PUBLIC UTILITY INDUSTRIES

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To

EMORY RICHARD JOHNSON, PH.D., SC.D.

Emeritus Professor of Transportation and Commerce
and former Dean of the Wharton School of Finance
and Commerce of the University of Pennsylvania,
this volume is dedicated in appreciation of his
distinguished attainments and services as
teacher, research scholar, and
administrator.

PREFACE

Changing economic, political, and social conditions in the United States, particularly during the past two decades, have caused new industries to emerge and existing industries to change the nature and extent of their services. Such changes have produced marked effects upon the public service industries, but there have been reciprocal effects produced by changes in these industries upon economic, political, and social life. The public service and public utility industries have not been in the past, and there are no present evidences discernible that they will be in the future, a fixed and immutable category, but they are a group from which industries disappear, in which the relative nature and importance of industries change, or to which new industries are added. This group of industries, however, occupies a special position or status in the economic organization. In supplying economic goods and services which society considers essential to its welfare, the public utility industries have come to be set apart and subjected to treatment differing from that accorded other industries. It is the purpose of this study to present descriptive and factual data necessary to an understanding of the nature and characteristics of the industries included in this special group. Railroad, water, and air transportation utilities have been purposely excluded from this study because these industries are adequately covered in other texts.

This volume first presents the general nature of the public utility industries, by considering the economic, legal, and sociological characteristics of the industries presently considered to lie in the public service or public utility category. Principles of public utility rate making are considered also from this general point of view. Following this general discussion the volume treats successively the economic features, organization, functions, services, rate structures, and policies of the manufactured and natural-gas industries, the electric light and power industries, the water-supply industries, the

motor transportation industries, urban streetcar and rapid transit industries, interurban electric railway industries, pipe line transportation industries, and telephone, telegraph, cable, and radio communication industries. A final chapter treats of the nature and significance of the trends toward the consolidation and combination of the utilities in vertical and horizontal patterns.

The authors have attempted in preparing these data to eliminate nonessentials and to discuss principles for the use and guidance of students who seek a factual basis for their thinking upon subjects involving the public utility industries of the United States. The technical aspects of the various industries and the broad problems of regulation have been discussed adequately by others; hence, no attempt is made here to describe the various technical processes involved in the performance of the public utility services or to survey such general problems as valuation and the determination of the rate base, fair return, standards of service, public relations, and public versus private ownership. It is the opinion of the authors that the true nature of public utility problems can be better appreciated if the elements of the organization and services of the various public utility industries are more fully understood by students before approaching such complex matters. The present volume humbly aspires to serve as an introduction to the broader problems common to all utilities, which are applicable to and affect specific utility industries in varying degrees and in different ways. This approach to the study of public utility problems seems to be justified from classroom experience, especially with undergraduate students.

Care has been exerted to exclude personal points of view or bias in the presentation of these descriptive materials. It is not the purpose of this volume to mold opinion but to serve as a factual introduction to the further study of the controversial problems of public utility ownership, operation, and regulation. Thus, those who look here for arguments for or against private or public ownership and operation or for views upon many of the controversial subjects in the field of public utilities will be disappointed.

It is hoped that the study will be of service to teachers and students in graduate and undergraduate courses and seminars

in public utility problems in universities and colleges and to some extent in institutions of secondary education. It is hoped also that those employed by utilities and by governmental agencies engaged in the regulation of public utilities may find much of value in a volume which brings together in convenient form a wide range of material. Others of the general public who as consumers, voters, and taxpayers are vitally concerned with the services and rates of these utility industries may also find data of value and interest to them in this volume.

Grateful acknowledgment is made by the authors to their associates, to the executives of public utility companies, and to members of Federal and state regulatory commissions and their staffs for the cooperation and assistance given in the preparation of this volume. Special acknowledgment is made to the Faculty Research Committee of the University of Pennsylvania for financial assistance in the collection and compilation of certain statistical materials used herein.

The documentation of the volume indicates the sources from which the materials have been drawn, although the authors assume responsibility for their use and interpretation.

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CONTENTS

PAGE

PREFACE vii

CHAPTER I

✓ THE CHARACTERISTICS OF PUBLIC UTILITIES 1
- Use of the term "public utility" 1
- Common callings or vocations 2
- Public and private businesses 3
- The legal concept of public utility 7
- Economic characteristics of public utilities 20
- Statutory definitions of public service businesses 22

CHAPTER II

✓ PRINCIPLES OF RATE MAKING 26
- The theory and purpose of the rate schedule 26
  - Economic principles of price 26
  - Demand and cost factors involved in rate making 27
  - Load factor 29
  - Diversity factor 30
  - Classification of customers 32
  - The theoretically correct rate structure 34
- Cost Allocation in the manufactured-gas industry 35
  - Demand and cost factors 35
  - Types of cost and their allocation to customers 38
- Rate forms 42

CHAPTER III

THE GAS INDUSTRY 51
- The manufactured-gas industry 51
  - Historical development 51
  - Production 55
  - Consumption 60
- The natural-gas industry 63
  - Production of natural gas 63
  - Production of natural gasoline 66
  - Production of liquefied petroleum gases 68
  - Future of natural-gas production 69
  - Transportation of natural gas 70
  - Natural-gas costs 72
  - Consumption of natural gas 74
  - Natural-gas rates 78
- Summary of gas development in the United States 81

PAGE

CHAPTER IV

THE ELECTRIC LIGHT AND POWER INDUSTRY 84
Origin and development. 84
Growth 87
Major trends in development. 92
Use by and cost to domestic customers 92
Appliance sales. 93
Electrification of industry 95
Rural electrification. 97
Fuels used in electrical generation. 100
Growth of large central stations 102
Transmission lines and interconnections 104
Holding companies 109
Extent and status of municipal ownership 111
National power policy and Federal power projects 112
Electric rates. 122

CHAPTER V

WATER-SUPPLY UTILITIES 129
Development of waterworks 129
Present status 130
Economic characteristics. 131
Some water-supply utility problems. 135
Finances. 135
The pumping station 137
The distribution system. 137
Water purification and treatment. 138
Metering, meters, and meter reading 140
Legal responsibility for pure water 143
Fire protection and water supplies 143
Water utility rates 147

CHAPTER VI

MOTOR TRANSPORTATION AS A PUBLIC UTILITY 156
Nature of the industry 156
The manufacturing industry 156
Private automobile transportation 159
The motor-truck industry and freight transportation 161
The motorbus 169
The taxicab 173

CHAPTER VII

URBAN TRANSPORTATION 176
Growth of American cities. 176
Development of urban street railway transportation. 178
The motorbus 186
The trolley bus. 188

PAGE
Coordination of local transportation 191
The service problem 194
Electric railway fares 197

CHAPTER VIII

URBAN RAPID TRANSIT 209
Need for rapid transit 209
Development of rapid transit 210
Financing rapid-transit projects 214
Subways versus elevated railways 222
Subway rolling-stock equipment 224
Coordination of rapid transit and surface transportation . . . 225
Rapid-transit fares 226

CHAPTER IX

INTERURBAN ELECTRIC RAILWAY TRANSPORTATION 229
Passenger transportation 229
Interurban electric railway fares 237
Electric railway freight transportation 237
Types of electric railway freight carriers 239
Advantages and disadvantages of electric railways in the development of freight transportation 240
Coordination of electric railway and motor freight transportation 242
Traffic practices 245
Freight rates 247

CHAPTER X

PIPE LINE TRANSPORTATION 249
Divisions of the petroleum industry 249
Development of pipe line transportation 252
Gasoline pipe line transportation 254
Organization of the industry 254
Control of pipe lines 257
Pipe line transportation costs 260
Use of pipe lines by outside shippers 263
Pipe line rates 264
Regulation of pipe line transportation 265

CHAPTER XI

TELEPHONE COMMUNICATION 272
Growth and development 272
Long-distance telephone communication 276
Radiotelephony 278
World telephone statistics 280
Economic characteristics 281
Telephone rate making 285

PAGE

CHAPTER XII

TELEGRAPH COMMUNICATION 298
Growth and development 298
Technical development 301
Private-wire services 305
Timed-wire service 306
Supplemental services 306
Economic characteristics 307
Telegraph rate making 308
Classes of service 310
The telegraph rate structure 313

CHAPTER XIII

CABLE COMMUNICATION 317
Transatlantic cable systems 317
Cable communication between the United States, the West Indies, Central and South America 320
Transpacific systems 323
Technical development 326
Economic characteristics 327
Cable rate making 330
Classes of service 331
Rates 333

CHAPTER XIV

RADIO COMMUNICATION 338
Growth and development 338
Radio broadcasting 345
Special radio-communication services 348
Government communication systems 349
Economic characteristics 350
Classes of service and rates 354
Regulation of radio communication 354
International agreements 354
Regulation in the United States 359

CHAPTER XV

COMBINATION AND COORDINATION IN PUBLIC UTILITIES 365
Extent of combination 365
In the steam railway industry 365
In the electric light and power industry 368
In the gas industry 371
In the electric railway transportation utilities 374
In the water service utilities 374
In the communication utilities 375
Motives impelling utilities towards combination 384
Disadvantages or dangers of combination 387

INDEX 393

PUBLIC UTILITY INDUSTRIES

CHAPTER I

THE CHARACTERISTICS OF PUBLIC UTILITIES

There is no unanimity of opinion among economists, jurists, businessmen, or administrative officials, as to just what economic activities or business enterprises are included within the category of public utilities, or public service undertakings. The terms "public utility" and "public service" are of such recent origin that the older dictionaries and encyclopedias do not recognize them as having special legal significance. The more recent economic and legal treatises, however, use either term as a generic classification including more or less well-defined types of natural or artificial persons having peculiar duties and obligations to serve the public in certain recognized ways, at reasonable rates and charges, and without unjust and unreasonable discrimination, preference, or prejudice among their patrons.

The term "public utility" may be used narrowly, as it sometimes is, to include purely local utilities such as electric, water, gas, telephone, heating, and street railway companies; or it may be used in a broader sense to include utilities which serve broader territorial fields—sectional, national, or international—such as railroads, pipe-line companies, telegraph companies, telephone companies, or radio communication companies, and other organizations serving large numbers of patrons in extensive geographical areas.

Although the terms "public utility" and "public service" are of relatively recent origin, the concept of the public nature of certain callings is of ancient derivation. Quite some time ago in England certain vocations had been set apart by custom as callings having characteristics distinguishing them from other occupations. These characteristics have been recognized and ruled upon by the courts from early times; and there have grown up codes of rights, duties, privileges, immunities, and obligations

surrounding and pertaining to the persons engaged in these lines of business or professional activity.

The Court of King's Bench of England, in 1613, in the case of *Rich v. Kneeland,* recognized as a common carrier under the common law, and held liable as such, a bargeman who was employed in transportation for hire between London and places in Kent.[1] In another seventeenth century decision under the common law, the Court of King's Bench, in *Jackson v. Rodgers,* affirmed the duty, "as the custom of England," of a common carrier to transport goods for a person wishing his services and tendering him his hire, provided the carrier had the facilities to transport the property.[2]

The Common Callings or Vocations.—There was much confusion in the common law of England with respect to the status of certain occupations as "common callings" with certain duties and obligations and privileges attaching thereto. The difficulty appears to have been caused mainly by the fact that the word "common" was used in connection with certain employments and an inference had been drawn from the use of the word "common" that these vocations were anciently set aside from other "private" vocations in so far as duties to the public and the government were concerned. The use of the term "common" in the fourteenth and fifteenth centuries in England does not appear to have such a connotation. The term seems to have been used to connote, rather, that the person pursued the vocation regularly or "commonly" as a business or livelihood, so that a "common porter" was one who made a business of acting as a porter or carrier of goods; a "common tailor," one who earned his living making clothing; and a "common surgeon," one who devoted his whole time to the practice of surgery or medicine as a profession. The large number of callings designated in the ancient English Year Books as "common" employments can be accounted for in no other way than that those who were engaged regularly or commonly in a vocation as a business were considered as being engaged in a "common," or commonly or customarily followed, employment. Some of the vocations noted as "common" employments in England in the fourteenth and fifteenth centuries include: common brewer, common

[1] King's Bench, 1613; Cro. Jac. 330, 79 Reprint, 282.
[2] King's Bench, 1683; 2 Show. 327, 89 Reprint, 968.

purchaser, common huckster, common farrier (horseshoer), common merchant, common cooker-up, common touter (business solicitor), common fripperer (dealer in old clothes), common victualer (food dispenser), common taverner, common smith, common tailor, common innkeeper, common mareshal (groom), common schoolmaster, common surgeon, common shaver or barber, common bellman, common makers of various articles, such as soapmakers and candlemakers, common vendor, common hoyman (boatman), common carrier, common kidder (animal attendant), common baker, common lighterman, common miller, common ferryman, common boatman, common badger (licensed beggar), common balance (weighmaster), common distiller, common porter, common builder, and numerous other vocations. The number of employments designated as "common" is so extensive and the vocations so varied that they cannot be considered as being characterized by the enjoyment of a monopoly, by the presence of a special trust or bailment, by a peculiar necessity, or by any of the special rights and duties to the public or to the government sometimes urged as being the hallmarks of common undertakings.

Public and Private Businesses.—The doctrine that certain callings are inherently "common" or public, as the term "common" is now used, is of comparatively modern origin and is based upon the conception of certain businesses as public or common and others as strictly private. As Adler has stated:

> The fundamental basis of this concept is that business occupations fall into two classes, one public and the other private, and that business activities of the latter type are not subject to special duties to the individuals served, and do not owe special duties to the state. This conception is founded in part at least upon, and has been developed largely through, the law of common carriers. "Common" in this connection was assumed to mean "public"—public in the sense of "subject to control by the state," and of owing special duties to the public held out to be served. It was recognized that originally there were other "common" employments, but it was stated that they also were under peculiar duties and this was explained on the basis of some exceptional relation to the public. . . . But no evidence of such exceptional relation has been produced.[1]

[1] ADLER, H. M., Business Jurisprudence, *Harvard Law Review*, vol. 28, pp. 135, 146, 1914.

The changing conditions which have surrounded economic activity and life in general have altered greatly the conceptions of public and private business which have prevailed from time to time. In the period of the colonial and early national history of the United States the sparse population of the country was scattered and the facilities for travel and communication were limited. Fuel, in the form of wood and later coal, was obtained locally or from near-by sources of supply by the individual consumers themselves or from small producers or middlemen. Light was obtained from candles or whale-oil lamps. The candles, lamps, and lanterns were often homemade or obtained from local dealers or makers. Water supply was obtained from near-by individual sources, such as wells, springs, or streams, and no companies devoted their attention exclusively to supplying water to large groups of consumers. A water-supply reservoir from which water was conveyed through large wooden pipes by gravity was constructed in Boston in 1652, but this was an exceptional enterprise.

Many individuals owned vehicles which were used for local land transportation and, on occasion, for long-distance travel, and some individuals owned small sailing craft for water transportation, principally used in the business of the owners. But the carters and ocean- and river-craft owners who carried persons or property for hire were usually small proprietors who served single routes or restricted areas. Many of these were recognized as public servants and common-carrier liability was imposed upon them by the common law as upon their prototypes and contemporaries in England.

Communication facilities were limited to a meager postal service and to the carrying of messages from place to place by messengers and dispatch bearers. The telephone, telegraph, cable, and radio had not been invented, and electric light and power, steam railroad and electric railway transportation, and other public utilities or public services had not yet appeared. The coming of these has revolutionized all modes of life, has altered radically the relationship of those who produce and those who consume commodities and services, and has changed fundamentally the relationships between producers of the services and government, and also between consumers and government.

Before the advent of newer forms of transportation and communication and the development of other public service industries, radical changes were to take place: (1) the population of the country increased; (2) the population became increasingly concentrated in large urban areas; (3) instrumentalities which altered the technique of living were invented; (4) there was a separation of the supply of commodities or services from their consumption—that is, the development of civilization proceeded to a point where individuals could no longer both produce and consume the articles and services necessary and desirable to sustain life; and (5) the production of the commodities and services was developed by individuals or business organizations specializing in the production and distribution of commodities and services needed by the consuming public.

The line of cleavage between "private business" and "public utility or public service enterprises" took more definite form in the United States in the decade or two following the Civil War. This line was often blurred and indistinct but there was a definite change in the relationship of the industries to the public once a distinction between "private" and "public" industries was observed. The category of public utilities was constantly evolving. New industries were added to the list of those considered to be public utilities from time to time as changes occurred in economic, political, and social conditions. Whether or not a given industry was to be considered a public utility or public service industry came to be a mixed question of law, economics, and sociology. The conditions responsible for this tendency to increase the number of industries considered to be public utilities may be summarized as follows:

1. The growth in size of communities.
2. The increasing complexity of urban life as contrasted with the more simple life in rural communities.
3. The increasingly minute subdivision of labor.
4. The increase in the amount of capital required in these industries.
5. The increase in size of public service industries and in the number of consumers served.
6. The separation of producers and distributors of commodities and services from those who consume the products.
7. The diffusion of the ownership of the securities of these industries.
8. The broadening of the use of the services or commodities produced by the industries among a larger number of consumers and over wider geographic areas.

9. The increased need for extraordinary corporate powers on the part of the industries serving the public, including such powers as the right of eminent domain.

10. The increasing trend toward monopoly or quasi monopoly in the industries purveying these commodities or services.

Dean Roscoe Pound, of Harvard University Law School, distinguishes in the common law two fundamental characteristics: (1) its extreme individualism; and (2) its treatment of individuals as members of a group. In discussing this second characteristic Dean Pound observes:

> It [the common law] is characterized by another element tending in quite another direction [from extreme individualism]; a tendency to affix duties and liabilities independently of the will of those bound, to look to relations rather than to legal transactions as the basis of legal consequences, and to impose both liabilities and disabilities upon those standing in certain relations as members of a class rather than upon individuals.[1]

This tendency, Dean Pound believes, is due to the early development of the common law during the period of feudalism, when the lords and their tenants had certain rights and duties with respect to one another imposed upon them not because of what they agreed to do but because they were members of a class or group. Consequently, it came to be recognized generally that the vocations falling within the group or class of what were regarded as public utility or public service occupations had certain rights, duties, and privileges with respect to the public, not because of what they had agreed to do as express-contract undertakings, but implied from the nature of the calling. Individuals and companies were free to engage or refrain from engaging in public service undertakings, but once engaged in these vocations they were governed by the rights and duties imposed upon these forms of business activity by the common law or by express provisions of statutes. In like manner, the public was free to use the services of public utilities or to refrain from using them, but once the individual members of the public became patrons of a public utility or public service company, the rights and duties of each were governed by the system of common law and statutory law which collectively

[1] POUND, ROSCOE, "The Spirit of the Common Law," p. 14, Marshall Jones Co., Boston, 1921.

constituted the public service or public utility law. The law of public service thus presented a strange mixture of compulsion and volition.

The term "public utility" came to be used eventually as a collective term applicable to a group of industries, not to any specific type of industry. The industries or occupations within the group were considered from both economic and legal viewpoints as public employments, and the property devoted to these services was held to be clothed with, or affected with, a public interest.

Summarizing the discussion of the public utility concept up to this point, it is clear that neither historical conceptions of common callings, nor the nature of the relationships of various business undertakings to the general public under the common law, are adequate to explain present classifications of public utilities. Attempts have been made to define public businesses as those which serve pressing public needs, but this test cannot be applied infallibly to distinguish public from private businesses, since many enterprises upon which the public is economically dependent for food, water, clothing, fuel, and shelter are not considered under the laws of the states to be public utility enterprises. Size is not the touchstone; for many large enterprises, especially those in the fields of finance, distribution, and production, are not considered to be public utilities, while smaller enterprises are held to lie within the public utility category. Nor is the existence of regulation the sole test, since industries which are not considered to be public utilities are subject to governmental regulation, although they are not regulated in the same ways or to the same extent. The distinction seems to be not in the kind of services rendered by the enterprise but in the manner of doing the service of whatever kind.[1] The answer to the question: What is a public utility? therefore, must be found in legislative acts and court interpretations.

Public Utility: The Legal Concept.—In the United States, the legal concept of public utilities had its beginning in the acceptance by the courts of transportation companies and warehouses as public service companies on the ground that transportation carriers and other bailees for hire were "regulatable in England

[1] Adler, H. M., Business Jurisprudence, *Harvard Law Review*, vol. 28, pp. 135, 156, 1914.

from time immemorial."[1] It is interesting to note that whereas the earlier carrier law in England and in the states of the United States emphasized the bailment responsibility of carriers as a characteristic of public enterprise, this feature has become less important in recent years, as is indicated by the practice of restricting the liability of carriers under certain conditions. The common carriers being recognized as public utilities, other enterprises analogous to transportation or related to this industry were drawn into the same category.

In a dissenting opinion in *German Alliance Insurance Co. v. Lewis*, decided in 1914, Associate Justice Lamar traced this spread of public utility status from the common carrier to other businesses, stating that public service companies

> . . . all have direct relation to the business or facilities of transportation or distribution—to transportation by carriers of passengers, goods, or intelligence by vehicle or wire; to distribution of water, gas, or electricity through ditch, pipe, or wire; to wharfage, storage, or accommodation of property before the journey begins, when it ends, or along the way. When thus enumerated they appear to be grouped around the common carrier as a public business.[2]

Common carriers, to mix the metaphor, may be said to be the matrix of the public utility classification. By relation and analogy, stockyards were held to be public utilities because they are intimately related to the business of transportation and because the stockyard business is analogous to the warehouse business and therefore subject to the same principles of law, although it is true also that stockyards are practical monopolies of a vast business.[3] Similarly, cold-storage warehouses have been held to be public service enterprises because of their connection with transportation as parts of the distribution system.[4] Thus, by analogy to transportation, various business enterprises have been held by the courts to be public service businesses. These include pipe lines, grain elevators, telephone companies, telegraph companies, cable companies, and many other types of business undertakings.

[1] *Munn v. Illinois*, 94 U. S. 113 (1876).

[2] 233 U. S. 389 (1876).

[3] *Ratcliff v. Wichita Union Stockyards Co.*, 74 Kan. 1, 86 Pac. 150 (1906); and *Stafford v. Wallace*, 258 U. S. 495 (1922).

[4] *Public Utility Commission v. Monarch Refrigerating Co.*, 267 Ill. 528, 108 N. E. 716 (1925).

Another method of approaching the problem of determining whether or not certain forms of business are public utilities has been followed by the courts in recent years. This method consists of examining each business to ascertain its character without resorting to analogy to business enterprises already considered public utilities. The underlying principle involved in this method is that certain kinds of businesses have such peculiar relation to the public interest that there is superimposed upon them the right of public regulation.[1] The emphasis in this method of distinction is shifted from historical analogy to present ideals. The test under this basis of judgment is this: Is the business under consideration a public business in the light of modern ideas and ideals to the extent that the right of public regulation is imposed upon it? This method does not break completely with the past and the method of historical analogy, however, because present ideas and ideals are the result of centuries of experience and habit which are certain to influence thinking.

In recent years the courts have tended to wait for the legislatures to declare a business to be of such nature as to come within the police regulatory power before passing upon the question judicially.[2] The result of this policy is to make the determination of the public utility status of an industry a matter for joint legislative and judicial process. There is a well-defined tendency on the part of state legislatures and of the Federal Congress to extend the power of the state and Federal governments in the regulation of business, and many businesses heretofore considered private businesses are being subjected to public regulation and control in a rising tide of governmental regulation. This tide has been checked at times by decisions of the courts which have held certain businesses legislatively declared to be public as private in nature, or which have restricted the regulatory powers of the government at certain points. But the list of businesses legislatively and judicially construed to be public in character and subject to governmental regulation as public utilities has been expanded greatly.

In the majority opinion of the United States Supreme Court in *Munn v. Illinois* the court held that

[1] *German Alliance Insurance Co. v. Lewis*, 233 U. S. 389, 411 (1913).
[2] *State v. S. P. and S. R. R.*, Wash. 599, Pac. 1110 (1916).

. . . when, therefore, one devotes his property to a use in which the public has an interest, he, in effect, grants to the public an interest in that use, and must submit to be controlled by the public for the common good, to the extent of the interest he has created.

This doctrine has been upheld in other cases, notably in the case of *Budd v. New York*, a case involving the regulation of grain elevators at Buffalo, New York. In this three associate justices of the Supreme Court, in a general declaration of dissent, stated the philosophy of those who object to the expanding category of businesses considered to be clothed with a public interest and subject to public regulation, in the following words:

The vice of the doctrine is, that it places a public interest in the use of property upon the same basis as a public use of property. (Property is devoted to a public use when, and only when, the use is one which the public in its organized capacity, to wit, the state, has a right to create and maintain, and, therefore, one which all the public have a right to demand and share in.) The use is public because the public may create it, and the individual creating it is doing thereby and pro tanto the work of the state. The creation of all highways is a public duty. Railroads are highways. The state may build them. If an individual does that work, he is doing pro tanto the work of the state. He devotes his property to a public use. The state doing the work fixes the price for the use. It does not lose the right to fix the price because an individual voluntarily undertakes to do the work. But this public use is very different from a public interest in the use. There is scarcely any property in whose use the public has no interest. No man liveth unto himself alone, and no man's property is beyond the touch of another's welfare. Everything, the manner and extent of whose use affects the well-being of others, is property in whose use the public has an interest. Take, for instance, the only store in a little village. All the public of that village are interested in it; interested in the quantity and quality of the goods on its shelves, and their prices, in the time at which it opens and closes, and generally, in the way in which it is managed; in short, interested in the use. Does it follow that the village public has a right to control these matters? That which is true of the single small store in the village, is also true of the larger mercantile establishment in the great city. The magnitude of the business does not change the principle. There may be more individuals interested, a larger public, but still the public. The country merchant who has a small warehouse in which the neighboring farmers are wont to store their potatoes and grain preparatory to shipment occupies the same position as the proprietor of the largest elevator in New York.

The public has, in each case, an interest in the use and the same interest, no more and no less. I cannot bring myself to believe that when the owner of property has by his industry, skill, and money, made a certain piece of his property of large value to many, he has thereby deprived himself of the full dominion over it which he had when it was of comparatively little value; nor can I believe that the control of the public over one's property or business is dependent upon the extent to which the public is benefited by it.

Surely the matters in which the public has the most interest, are the supplies of food and clothing; yet can it be that by reason of this interest the state may fix the price at which the butcher must sell his meat, or the vendor of boots and shoes, his goods? Men are endowed by their creator with certain inalienable rights, "life, liberty, and the pursuit of happiness"; and to "secure," not grant or create these rights, governments are instituted. That property which a man has honestly acquired, he retains full control of, subject to these limitations: First, that he shall not use it to his neighbor's injury, and that does not mean that he must use it for his neighbor's benefit; second, that if he devotes it to a public use, he gives to the public a right to control that use; and, third, that whenever the public needs require, the public may take it upon payment of due compensation.

There is suggested that there is a monopoly, and that that justifies legislative interference. There are two kinds of monopoly, one of law, the other of fact. The one exists when exclusive privileges are granted. Such a monopoly, the law which creates alone can break; and being the creation of law justifies legislative control. A monopoly of fact anyone can break, and there is no necessity for legislative interference. It exists when anyone, by his money and labor, furnishes facilities for business which no one else has. A man puts up in a city the only building suitable for offices. He has therefore a monopoly of that business; but it is a monopoly of fact which anyone may break who, with like business courage, puts his means into a similar building. Because of the monopoly feature, subject thus easily to be broken, may the legislature regulate the price at which he will lease his offices? So here, there are no exclusive privileges given to these elevators. They are not upon public ground. If the business is profitable, anyone can build another; the field is open for all the elevators, and all the competition that may be desired. If there be a monopoly, it is only of fact and not one of law, and one which any individual can break.

The paternal theory of government is to me odious. The utmost possible liberty to the individual, and the fullest possible protection to him and his property, is both the limitation and duty of government. If it may regulate the price of one service, which is not a public service, or the compensation for the use of one kind of property which is not

devoted to a public use, why may it not with equal reason regulate the price of all service, and the compensation to be paid for the use of all property?[1]

The theory of law expounded by Justices Brewer, Field, and Brown, in this dissenting opinion in *Budd v. New York*, persists with modification in the minds of many who hold relatively conservative opinions with respect to the relationship of government and property rights. However, the general tendency seems to be in the direction of expanding the category of public utilities to include more and more industries of differing kinds.

Perhaps the clearest conceptions of the underlying principles involved in the confused problem of public utility status are to be found in two decisions of the United States Supreme Court. In the first of these, the case of *Charles Wolff Packing Co. v. the Industrial Court of Kansas*, the late Chief Justice Taft, writing the majority opinion of the court, divided businesses clothed with a public interest justifying some public regulation into three classes:

> 1. Those which are carried on under a public grant of privileges which either expressly or impliedly imposes the affirmative duty of rendering a public service demanded by any member of the public. Such are the railroads, other common carriers, and public utilities.
> 2. Certain occupations, regarded as exceptional, the public interest attaching to which, recognized from earliest times, has survived the period of arbitrary laws by Parliament or colonial legislatures for regulating all trades and callings. Such are those of the keepers of inns, cabs, and gristmills. . . .
> 3. Businesses which though not public in their inception may be fairly said to have risen to be such and have become subject in consequence to some government regulation. They have come to hold such a peculiar relation to the public that this is superimposed upon them. In the language of the cases, the owner by devoting his business to the public use, in effect grants the public an interest in that use and subjects himself to public regulation to the extent of that interest although the property continues to belong to its private owner and to be entitled to protection accordingly.[2]

This classification recognizes the factors of public assistance, historical analogy, and devotion to the public interest. It

[1] 143 U. S. 517 (1892).
[2] 262 U. S. 522 (1923).

does not recognize the tendency expressed by the legislatures of certain states, notably in the establishment of the Kansas Industrial Court, in endeavoring to make "public utilities" and "necessities of life" approximately interchangeable terms.

The devotion of the property to the public service while retaining the private interest of the owner or owners of the property appears to be a very significant hallmark of a business so affected with a public interest as to justify public regulation. Thus, in *Munn v. Illinois*, Chief Justice Waite observed that "private property does become clothed with a public interest when used in a manner to make it of public consequence."[1]

In the comparatively recent case of *Tyson & Brother v. Banton*, Mr. Justice Sutherland stated:

> The significant requirement is that the property shall be devoted to a use in which the public has an interest, which simply means . . . that it shall be devoted to a "public use." Stated in another form, a business or property, in order to be affected with the public interest must be such or be employed so as to justify the conclusion that it has been devoted to a public use and its use thereby, in effect, granted to the public.[2]

The determination as to whether or not a particular industry is "affected with a public interest" in a judicial sense is not a simple problem, however. Again and again state legislatures and the courts have disagreed over this vital matter. The United States Supreme Court has held that state legislatures cannot convert a private business into a public utility by mere legislative fiat, and consistently has held the states to this limitation in order to afford the owners of businesses the protection guaranteed by the United States Constitution.[3] Nevertheless, the United States Supreme Court has held that whether or not local conditions justify the conversion of private businesses into public enterprises is a matter primarily for the respective state legislatures to determine, subject to judicial review, but with the presumption of validity that attends such enactments. The legislative actions of the states must be held valid unless they are clearly arbitrary, capricious or unreasonable. Thus, in the

[1] 94 U. S. 113, 126 (1876).

[2] 273 U. S. 418, 433–434 (1926).

[3] *Producers Transportation Co. v. Railroad Commission Calif.*, 251 U. S. 288 (1920).

case of the *Chicago, Burlington & Quincy Railroad Co. v. McGuire*, the Supreme Court stated that

. . . whether the enactment is wise or unwise, whether it is based on sound economic theory, whether it is the best means to achieve the desired result, whether, in short, the legislative discretion within its prescribed limits should be exercised in a particular manner, are matters for the judgment of the legislature, and the earnest conflict of serious opinion does not suffice to bring them within the range of judicial cognizance.[1]

The right of a state legislature to declare a particular business a public utility and to regulate it as such was at issue in the second case to which attention is called, *New State Ice Co. v. Liebman.* The majority of the court held that although the business of manufacturing, selling, and distributing ice might be subjected to appropriate regulations in the interest of public health, it was not a business so charged with a public use as to justify a state statutory requirement of a license for such a business. Associate Justice Sutherland, in delivering the opinion of the court, said:

It is plain that unreasonable or arbitrary interference or restrictions cannot be saved from condemnation (under the Fourteenth Amendment of the Federal Constitution) merely by calling them experimental. It is not necessary to challenge the authority of the states to indulge in experimental legislation; but it would be strange and unwarranted doctrine to hold that they may do so by enactments which transcend the limitations imposed upon them by the Federal Constitution. The principle is embedded in our constitutional system that there are certain essentials of liberty with which the state is not entitled to dispense in the interest of experiments.[2]

Mr. Justice Brandeis in an extended dissenting minority opinion, in which Mr. Justice Stone concurred, closely examined the tangled strands of economics, law, and sociology, and ably discussed the economic and social justification for experimentation in legislation of this type. He observed:

To stay experimentation in things social and economic is a grave responsibility. Denial of the right to experiment may be fraught with serious consequences to the nation. It is one of the happiest incidents

[1] 219 U. S. 549 (1910).
[2] 285 U. S. 262 (1932).

of the Federal system that a single courageous state may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country. This court has the power to prevent an experiment. We may strike down the statute which embodies it on the ground that, in our opinion, the measure is arbitrary, capricious, or unreasonable. We have power to do this, because the due-process clause has been held by the court applicable to matters of substantive law as well as to matters of procedure. But in the exercise of this high power, we must forever be on our guard, lest we erect our prejudices into legal principles. If we would guide by the light of reason, we must let our minds be bold.

Elsewhere in his minority opinion in this case, Mr. Justice Brandeis made an eloquent and forceful plea for economic and social open-mindedness in reviewing the problems of modern economic life. He said, in part:

. . . Oklahoma declared the business of manufacturing ice for sale and distribution a "public business," that is a public utility. So far as it appears, it was the first state to do so. . . . Of course, a legislature cannot by mere legislative fiat convert a business into a public utility (case cited). But the conception of a public utility is not static.

. . . The welfare of the community may require that the business of supplying ice be made a public utility, as well as the business of supplying water or any other necessary commodity or service. If the business is, or can be made, a public utility it must be possible to make the issue of a certificate a prerequisite to engaging in it.

Whether the local conditions are such as to justify converting a private business into a public one is a matter primarily for the determination of the state legislature. . . . "The Legislature being familiar with local conditions is, primarily, the judge of the necessity of such enactments. The mere fact that a court may differ with the legislature in its views of public policy, or that judges may hold views inconsistent with the propriety of the legislation in question, affords no ground for judicial interference, . . . " (*McLean v. Arkansas*, 211 U. S. 529, 547).

In Oklahoma a regular supply of ice may reasonably be considered a necessity of life, comparable to that of water, gas, and electricity. The climate, which heightens the need of ice for comfortable and wholesome living, precludes resort to the natural product. . . . There, as elsewhere, the development of the manufactured-ice industry in recent years . . . has been attended by deep-seated alterations in the economic structure and by radical changes in habits of popular thought and living.

Ice has come to be regarded as a household necessity, indispensable to the preservation of food and so to economical household management

and the maintenance of health. . . . Its commercial uses are extensive. In urban communities, they absorb a large portion of the total amount of ice manufactured for sale. . . . The transportation, storage, and distribution of a great portion of the nation's food supply is dependent upon a continuous and dependable supply of ice.

. . . The question whether in Oklahoma the means of securing refrigeration otherwise than by ice manufactured for sale and distribution has become so general as to destroy popular dependence upon ice plants is one peculiarly inappropriate for the judgment of this court, which cannot have all the knowledge of all the relevant facts.

The business of supplying ice is not only a necessity, like that of providing for food or clothing or shelter, but the legislature could also consider that it is one which lends itself peculiarly to monopoly.

Competition in the industry tends to be destructive because ice plants have a determinate capacity, and inflexible fixed charges and operating costs, and because in a market of limited area the volume of sales is not readily expanded. Thus the erection of a new plant in a locality already adequately served causes managers to go to extremes in cutting prices in order to secure business.

Trade journals and reports of association meetings of ice manufacturers bear ample witness to the hostility of the industry to such competition, and to its unremitting efforts, through trade associations, informal agreements, combination of delivery systems, and in particular through the consolidation of plants, to protect markets and prices against competition of any character. . . .

That these forces were operative in Oklahoma prior to the passage of the act under review, is apparent from the record. Thus it was testified that in only six or seven localities in the state, containing in the aggregate not more than 235,000 of the total population of approximately 2,000,000, was there a "semblance of competition" . . . and that even in these localities the prices of ice were ordinarily uniform.

The balance of the population was, and still is, served by companies enjoying complete monopoly. . . .

When there was competition, it often resulted to the disadvantage rather than to the advantage of the public, both in respect to prices and to service. Some communities were without ice altogether, and the state was without means of assuring their supply. There is abundant evidence of widespread dissatisfaction with ice service prior to the Act of 1925, . . . and of material improvement in the situation subsequently. It is stipulated in the record that the ice industry as a whole in Oklahoma has acquiesced in and accepted the act and the status which it creates.

. . . For 17 years prior to the passage of the Act of 1925, the Corporation Commission under section 13 of the Act of June 10, 1908, had

exercised jurisdiction over the rates, practices, and services of ice plants, its action in each case, however, being predicated upon a finding that the company complained of enjoyed a "virtual monopoly" of the ice business in the community which it served. . . .

. . . The advisability of treating the ice business as a public utility and of applying to it the certificate of convenience and necessity had been under consideration for many years. . . .

The measure bore a substantial relation to the evils found to exist. Under these circumstances to hold the act void as being unreasonable, would, in my opinion, involve the exercise not of the function of judicial review, but the function of a super-legislature. If the act is to be stricken down, it must be on the ground that the Federal Constitution guarantees to the individual the absolute right to enter the ice business, however detrimental the exercise of that right may be to the public welfare. Such, indeed, appears to be the contention made.

. . . The claim is that manufacturing ice for sale and distribution is a business inherently private, and in effect that no state of facts can justify denial of the right to engage in it. . . .

Whether it is, or is not, depends upon the conditions existing in the community affected. . . . If it is a matter of public concern it may be regulated, whatever the business. The public's concern may be limited to a single feature of the business, so that the needed protection can be secured by a relatively slight degree of regulation. . . .

On the other hand, the public's concern about a particular business may be so pervasive and varied as to require constant detailed supervision and a very high degree of regulation. Where this is true it is common to speak of the business as being a "public" one, although it is privately owned. It is to such businesses that the designation "public utility" is commonly applied; or they are spoken of as "affected with a public interest."

. . . It is urged specifically that manufacturing ice for sale and distribution is a common calling; and that the right to engage in a common calling is one of the fundamental liberties guaranteed by the due-process clause. To think of the ice-manufacturing business as a common calling is difficult; so recent it is in origin and so peculiar in character. Moreover, the Constitution does not require that every calling which has been common shall ever remain so.

. . . It is no objection to the validity of the statute here assailed that it fosters monopoly. That, indeed, is its design. The certificate of public convenience and necessity is a device—a recent social-economic invention—through which the monopoly is kept under effective control by vesting in a commission the power to terminate it whenever that course is required in the public interest. To grant any monopoly to any person as a favor is forbidden even if terminable.

But where, as here, there is reasonable ground for a legislative conclusion that in order to secure a necessary service at reasonable rates, it may be necessary to curtail the right to enter the calling, it is, in my opinion, consistent with the due-process clause to do so, whatever the nature of the business.

. . . The economic emergencies of the past were incidents of scarcity. In those days it was preeminently the common callings that were the subject of regulation. The danger then threatened was excessive prices. To prevent what was deemed extortion, the English Parliament fixed the prices of commodities and of services from time to time during the four centuries preceding the Declaration of Independence. . . . Like legislation was enacted in the colonies; and in the United States, after the Revolution. . . .

When the first due-process clause was written into the Constitution, the price of bread was being fixed by statute in at least two of the states, and this practice continued long thereafter.

The conflict between the majority and minority opinions in the New State Ice case as to whether or not the people speaking through their elected representatives should be allowed to determine the nature and scope of regulation of various industries in order to secure a necessary service at reasonable rates concerns a fundamental issue which frequently has been before the Supreme Court of the United States. Concerning the powers of the court where differences of opinion between it and the state legislatures exist former Justice Holmes made the following significant statement, in a dissenting opinion in *Tyson & Brother v. Banton*, cited above:

I think the proper course is to recognize that a state legislature can do whatever it sees fit to do unless it is restrained by some express prohibition in the Constitution of the United States or of the state, and that courts should be careful not to extend such prohibitions beyond their obvious meaning by reading into them conceptions of public policy that the particular court may happen to entertain. Coming down to the case before us I think, as I intimated in *Adkins v. Children's Hospital*, 261 U. S. 525, 569, that the notion that a business is clothed with a public interest and has been devoted to the public use is little more than a fiction intended to beautify what is disagreeable to the sufferers. The truth seems to be that, subject to compensation when compensation is due, the legislature may forbid or restrict any business when it has a sufficient force of public opinion behind it. Lotteries were thought useful adjuncts of the state a century or so ago; now they are believed to be immoral and they have been stopped. Wine has

been thought good for man from the time of the Apostles until recent years. But when public opinion changed it did not need the Eighteenth Amendment, notwithstanding the Fourteenth, to enable a state to say that the business should end. *Mugler v. Kansas*, 123 U. S. 623. What has happened to lotteries and wine might happen to theaters in some moral storm of the future, not because theaters were devoted to a public use, but because people had come to think that way.

But if we are to yield to fashionable conventions, it seems to me that theaters are as much devoted to public use as anything well can be. We have not that respect for art that is one of the glories of France. But to many people the superfluous is the necessary, and it seems to me that government does not go beyond its sphere in attempting to make life livable for them. I am far from saying that I think this particular law a wise and rational provision. That is not my affair. But if the people of the State of New York speaking by their authorized voice say that they want it, I see nothing in the Constitution of the United States to prevent their having their will.[1]

The above opinion was given by former Justice Holmes, and concurred in by Justice Brandeis, in dissent from a decision of the majority of the Supreme Court invalidating a statute of the State of New York declaring that the price or charge for admission to theaters and other places of amusement is a matter affected with a public interest, and limiting the price of resale of theater tickets. In other cases, as we have seen, the court has held not to be public utilities the manufacture, preparation, and sale of food and clothing for human consumption, and the preparation and sale of any substance for fuel; and the manufacture, sale, and distribution of ice. To these may be added others, like the marketing and sale of gasoline. In practically all of these cases there were differences of opinion, not only between the Supreme Court and the state legislatures, but between different members of the court, both as to the nature of industries which may be given public utility status and as to the right of state legislatures to determine what conditions warrant the imposition of such status. Where authoritative opinions differ so fundamentally it would be presumptuous for us to attempt to define precisely the public utility concept. The status of an industry is finally determined only when the Supreme Court of the United States after judicial consideration has declared it to be, or not to be, a public utility.

[1] 273 U. S. 418, 446–447.

Characteristics of Public Utilities.—While there are no classifications of public utilities on the basis of economic characteristics which are wholly adequate to distinguish these industries from others, the enumeration of such characteristics will serve a useful purpose. Mr. Morris L. Cooke summarizes the characteristics peculiar to the commodities or services supplied by public utilities in the following manner:

In the first place, the product sold is either a service or a commodity and service combined. In the case of steam and electric railways, telephone and telegraph, it is a service primarily that of transportation, either of goods and persons, or of messages, spoken or written. In water, gas, and electric current, the delivery of the commodity produced is an integral part of its production, and is of a sort which makes a single unified system of distribution by far the most economical. In this respect it differs from meat and bread, soap, clothing, or machinery.

Further, the product is consumed locally, in close connection with its distribution. This is true also of irrigation works, for example, which constitute a sort of water works; while canals partake of the nature of railways; and bridges, wharves, and docks are parts of the transportation system of terminals.

In the third place, the product is highly standardized. There is less difference between one kilowatt of electric current and another, between a cubic foot of gas consumed in one part of a city and that in another, than between one brand of breakfast food and another, one make of soap and another, one trade-marked fabric or piano and another. And so with rail transportation, while it may be a trifle more rapid by one line than by another, those differences tend to become standard, and vice versa, and the entire industry becomes unified and simplified—one in which processes and products are fixed and known. Again there is little storage possible; there is no holding back for higher prices; the product is consumed almost as fast as it is produced.

Moreover, it is a cash business, or virtually cash, which the utilities carry on. If bills are not paid promptly, service is shut off. The continuing necessity for the product or service operates to divide the annual sales into monthly units, each of which must be paid promptly.

While there are certain differences between those utilities which handle both commodities and their distribution (by wire or pipe lines), and those which supply the transportation exclusively, these common characteristics distinguish them from the ordinary, competitive products of industry.[1]

[1] Cooke, Morris L., "Public Utility Regulation," pp. 16–17, Ronald Press Company, New York, 1924.

These industries also have certain duties and obligations to the public which distinguish them more or less clearly from other businesses. These are:

1. Public utilities are under obligation to serve all who apply for their services and who are willing to pay the reasonable rates and charges of these companies. Those engaged in private business may serve those whom they choose to serve, or refuse to serve those whom they do not wish to serve.

2. Public utilities must serve the public up to the limit of their capacities. They may refuse to serve if their facilities are unsuited to perform the services demanded, but the inadequacy of the facilities must be actual and not merely a subterfuge to cloak some other reason. Moreover, there is a growing tendency to interpret capacity not merely as physical capacity but the limit of profitableness.

3. Public utilities must serve the public without unjust or unreasonable discrimination and without unfair preference or prejudice among the actual or prospective patrons similarly circumstanced.

4. The rates or charges of public service companies must be just and reasonable for the service performed and with respect to those served.

5. Public utilities, as a rule, may not commence operation or extend their services without first having received evidences of public approval from the duly constituted regulatory bodies having jurisdiction.

6. Public utilities may not attach unreasonable conditions to their services which may act as restrictions to the reasonable use thereof.

7. Public service companies must observe extraordinary care in rendering their services to protect their patrons and the public generally.

8. Public service companies may not withdraw from service at will without due notice.

In compensation for these extraordinary duties and responsibilities public utilities are accorded the following privileges:

1. The public service industries are endowed with certain powers superior to the powers granted ordinary business enterprises, such as the power of eminent domain,—to condemn private property for public use, a prerogative of sovereignty.

2. The patrons of public service companies are required by law to observe their reciprocal obligations to the public service companies such as the payment of charges, the protection of property of public service companies, granting rights of way, and other duties.

3. The public service companies have the right to expect reasonable protection against ruthless competition which is destructive to the rights and properties of the public service companies and detrimental to the best interests of the public.

4. Public service companies have the right to reasonable compensation for their services. The Federal and state governments may not deprive the public service companies of their properties without due process of law. This places a definite limitation upon governmental regulatory bodies to the effect that rates and charges may not be regulated so severely that the result thereof is the confiscation of the properties of the public service agencies.

Statutory Definitions of Public Service Businesses.—The term "public service company" as it is used in the laws of the several states is defined in the legislative acts of those states. The Public Service Company Law of the Commonwealth of Pennsylvania, as amended, for example, defines public service companies by enumerating 27 kinds of companies which are declared to be public service companies when the services performed by the companies are for profit and not for the sole use of the owners or tenants of the owners. These include transportation companies, communication companies, storage companies, and electric and other home service companies. The classifications include:

1. Transportation companies:
   a. Railroad corporations.
   b. Street railway companies.
   c. Canal corporations.
   d. Express companies.
   e. Stage lines.
   f. Baggage transfer companies.
   g. Ferry companies.
   h. Pullman car companies.
   i. Dining car companies.
   j. Tunnel companies.
   k. Bridge companies.
   l. Turnpike companies.

m. Wharf companies.
n. Inclined plane railway companies.
o. Pipe line companies.
p. All common carriers.

2. Communication companies:
   a. Telegraph companies.
   b. Telephone companies.
   c. Wireless and radio communication companies.
3. Storage companies:
   a. Grain elevator companies.
4. Home service companies:
   a. Natural gas companies.
   b. Artificial or manufactured gas companies.
   c. Electric companies.
   d. Water companies.
   e. Water-power companies.
   f. Heating companies.
   g. Refrigerating companies.
   h. Sewage companies.

It is provided by the Pennsylvania Public Service Company Law that the act applies to all corporations or companies or persons in these categories doing business for profit within the state, and also to persons and corporations of these classes, which do not furnish these services within the state, but "whose rates, charges, facilities, or service affect the rates, charges, facilities, or service of a public service company doing business within the state." The act specifically excludes the generation, transmission, or distribution of electricity; the manufacture or distribution of gas; the furnishing and delivery of water; the production delivery, or furnishing of steam, or any other substance for heat or power, "by a producer, who is not otherwise a public service company, for the sole use of the producer or for the use of the tenants of the producer, and not for sale to others."[1]

The Pennsylvania Public Service Company Law is especially broad and inclusive in its definition of the term "common carrier," common carriers including all corporations or persons engaged for profit in the conveyance of persons or property, or both, "by, through, over, above, or under land or water, or both." It is difficult to conceive of any common carrier which would not come within this comprehensive definition. The law is equally broad with respect to the terms "service" and "facilities," the act specifically providing that the term "service" shall be con-

[1] Public Service Law, Commonwealth of Pennsylvania, Art. 1 Sec. 1.

strued in the broadest and most inclusive sense. In like manner the term "facilities" is construed to include all plants and equipment of public service companies, including tangible and intangible real and personal property of almost every type and description.

In some states the category of public service companies is less comprehensive than in Pennsylvania, while in other states local industries such as aerial-bucket tramways and cotton-ginning companies are placed within the class of public enterprises. Most statutes are quite comprehensive, however. To take another illustration, the statutory classification of public utilities in the State of Illinois includes as industries subject to the jurisdiction of the Illinois Commerce Commission all which provide transportation of passengers or property for hire; the transmission of messages by telephone or telegraph; the production, transmission, distribution, storing, sale, delivery, or furnishing of electric light or power, gas, heat, cold or hot water; the transportation of petroleum or natural or manufactured gas by pipe line; the storage or warehousing of goods; and the operation of wharves, docks, and certain other auxiliary facilities of transportation and commerce.

Summary.—In summary it might be said that the final determination of the public or private nature of an industry is a mixed question of law and fact; a problem in which economics, the common law, statutory law, history, political science, sociology, and sanitary science all play a part. A legislature may not convert a private industry into a public enterprise by mere legislative fiat, but in the determination of the private or public status of a given industry the legislature may exercise its judgment, subject to judicial review, but with the presumption of validity which attends the enactment of state statutes.

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CHAPTER II

PRINCIPLES OF RATE MAKING

THE THEORY AND PURPOSE OF THE RATE SCHEDULE

The schedule of charges for public utility services or products seems frequently to be complicated and often unrelated to the economic principles of price or value. Analysis of public utility rate making and rate schedules, however, should be made in terms of economic principles as related to the particular conditions present in public utility enterprises.

Without reviewing in detail the economic principles of price determination, it may be pointed out that in competitive enterprises prices are determined largely by forces out of control of any one of the enterprises. The price received for the product at any given time depends upon the operation of the forces of supply of the product and the demand for it. The ability of a producer, therefore, to earn a profit depends upon his ability to produce his product (or service) at a cost less than the price determined on the competitive market. Where a producer has a monopoly, however, it is a familiar concept that the supply will be controlled so as to enable it to be sold at a price which will yield a maximum profit. The monopolist, therefore, attempts to determine his costs of production for various quantities of his product, and to estimate the demand for or the price that buyers will pay for these various quantities. Supply will then be controlled at that point which yields the greatest profit. Since public utilities operate largely under conditions of monopoly, any given public utility is free to fix the rates for its products or services at that figure which would yield it the largest net profit. It is at this point that complications enter into the rate-making activities of the public utility. One of the usual characteristics of a public utility business is that it has a heavy capital investment in proportion to its income. In other words, the rate of turnover for public utility capital is relatively slow. Economic and social changes must be considered and they will

reflect themselves in the rate schedule. Nor are public utilities absolute monopolies—some competitive forces are usually present. Another complicating factor is that there are usually a large number of public utility consumers and a great variety of uses to which any given public utility service may be put. The value of the service to these different consumers varies and it is thus necessary to introduce different scales of charges to the several classes of customers. A final limiting factor is the system of public regulation in the United States which aims to keep rates on a reasonable and nondiscriminatory basis. The effect of these various influences in rate making for public utilities will be noted as the theory and purpose of the rate structure is explained.

From a theoretical standpoint, the rate schedule is a device whereby charges for the product (or service) are assessed against the user of the product. The rate schedule, then, must be devised in such a way that it considers all the factors entering into the value of the product or service. On the side of supply, the cost of production is the basic consideration. On the side of demand, the basic consideration is the willingness of the consumers to use the product and their ability and willingness to pay for it.

On the side of demand, it is usually conceded that public utility products and services are essential to the well-being of the group and willingness to use the products is present to a greater or lesser extent. Availability of substitute products and differences in desire to consume the given product will cause this demand factor to exhibit a greater or less degree of elasticity. The rate schedule must reflect this condition if the public utility supplying the product is to earn a fair return. Elasticity in demand is one of the reasons why rate schedules are formulated with rates per unit of product decreasing as the quantity consumed is increased. On the supply side, the costs of providing the product must be determined (or estimated). At this point, it should be repeated that due to the essential nature of public utility products and services, it is usually believed that the product will be consumed if the costs are not unreasonably high. For this reason, emphasis is usually placed upon the analysis of costs of production and their influence upon the types or kinds of rate schedules and the level of the rates. For all practical

purposes, therefore, conditions of supplying the product and costs encountered therein come to be the basis of the rate structure. The theoretical statement, from this view, is that the rate structure is supposed to reflect the costs of production and to allocate those costs to the users of the product responsible for them.

The particular conditions of cost which make public utilities differ from other industries are two. In the first place, the rate of turnover for capital invested in public utilities is relatively slow. Some commercial enterprises have a capital turnover of two or more times per year. Many manufacturing enterprises also have a capital turnover rate of two or more times per year, though the rate of turnover in others will be somewhat slower. Utilities, on the other hand, seldom turn their capital over in less than three years and the rate of turnover for many will be once in five or six years. Stated in another way, utilities require from $3 to $6 of capital for every dollar of gross annual income while manufacturers require only $1 for every $2 to $4 of gross annual income and commercial enterprises, with their more rapid turnover, require only $1 of capital for every $2 to $10 of gross income. The statement that public utilities have a relatively large capital investment becomes significant when this is realized. The costs incidental thereto must be carefully considered in order that they will be returned out of the comparatively small gross income received.[1] In the second place, the investment of the public utility is not primarily in the commodity or service which it sells but is in the fixed assets which it does not sell. Its business is not like that of the merchant selling piecemeal the property in which he has principally invested. Further, a part of this investment is ordinarily devoted to the particular customer using the product and cannot be shifted to another customer without encountering expenses for additional distribution system, meters, etc.[2] To summarize, public utilities ordinarily have a large capital investment which gives rise to a large proportion of fixed costs. It is not to be concluded, however, that variable costs are unknown in this field. Variable costs are encountered in providing for varying

[1] American Gas Association, "Principles of Rate-making for Gas Companies," Report of the Rate Structure Committee, 1926, Appendix, p. 6.

[2] American Gas Association, "Better Forms of Rates for Gas," p. 15.

quantities of output. The point of emphasis is that variable costs comprise a relatively small proportion of total costs.

The total cost of carrying on the business may be divided as follows:

1. Interest on capital invested—the costs required to provide the facilities for doing business. This is a fixed cost.

2. Depreciation—the amount which must be set up to provide for maintaining the investment. This is largely a fixed cost.

3. Operation—the cost of producing and distributing the product or service and the cost of incidental service to customers. These are variable costs.

The rate schedule is the device whereby these costs are assessed against the users of the product. If responsibility for the amounts invested in plant and equipment and their depreciation were directly related to quantity of output, it would then be a simple matter to charge each customer a given amount for each unit of the product or service that he used. In such a case, each customer would return to the company his full share of both fixed and variable costs. But there is no such direct relationship between quantity of output taken by each customer and his responsibility for investment in plant and equipment. This arises from the fact that the public utility plant must be constructed so as to provide a plant sufficient in size to meet the maximum demands of all customers. It is characteristic that this maximum demand occurs only for a short period each day, week, season, or year. Most of the time the capacity of the plant is utilized only to a small extent while the fixed costs remain constant.

Thus, a consumer who makes use of the plant almost entirely at the "peak of the load" requires plant facilities proportionate to the rate of supply required at that time. For this capacity, there may be no use at other times and it therefore remains idle. On the other hand, a consumer whose demand is almost or entirely "off peak" requires little or no additional plant capacity and therefore imposes no fixed charges attributable directly to him.[1] This is particularly important to those utilities, such as electric light and power supply, which must produce their product or service at the moment of consumption and where storage is not available.

[1] Watkins, G. P., "Electrical Rates," p. 15, D. Van Nostrand Company, Inc., New York, 1931.

The concept of the load factor, therefore, plays an important part in the determination of a rate schedule which satisfactorily allocates the costs of production to the consumers (or classes of consumers) responsible therefor. In simplest terms, the load factor may be defined as the ratio of average to maximum demand during a certain period of time.[1] The rate of output of the public utility plant at any given time corresponds to the utilized capacity, or the load, at that time. The average output is thus determined by dividing the total annual output by the number of units of time (hours, days, weeks) in the year. This gives one of the items in the ratio—average demand. The maximum demand, the other item in the ratio, is the highest recorded output for the interval of time selected. Subsequent analysis of production conditions of particular public utility industries will indicate the importance of the load factor to each industry. The influences of the load factor on the rate schedule may be briefly summarized here, however, as (1) the necessity of designing a rate schedule which assesses "peak costs" upon peak users, and (2) the desirability of designing a rate schedule which promotes "off-peak" uses and increases average demand, thereby improving the load factor. The desirability of improving the load, *i.e.*, average use, causes the rate schedule to be modified in such a way that low rates will be offered the "off-peak" users. The higher rates assessed against the "peak" users, at the same time, are justified on grounds that they are the users primarily responsible for the investment in plant and equipment necessary to provide the peak supply.

If the rate structure were so designed that it would apply to each customer's actual maximum demand, either hourly, daily, weekly, or seasonal, an amount of revenue greater than the necessary return would be received. This is due to what is known as diversity in the demands of customers. The rate structure, as constructed to recognize the influence of the "load factor," is modified to reflect this so-called "diversity factor." The diversity factor may be defined as the ratio of the non-coincident demands of the customers to the actual maximum demand on the system. The maximum demand of a given customer will not always coincide with the maximum demand,

[1] For more detailed definition see American Institute of Electrical Engineers, Standardization Rules, *Transactions*, 1916.

in point of time, of all customers. There is diversity of use among the customers of all types of public utility enterprises. It follows, therefore, that the sum of the noncoincident maximum demands for the customers will always exceed the actual maximum demand on the system. The diversity factor is thus always greater than 1.

In order that the costs may be assessed against the customers responsible for them, it has been pointed out that the maximum use, or demand, as indicated by the load factor, is employed. When rate schedules reflect this situation, a part of the rate is determined by the maximum demand of the customer. The basis for apportioning these so-called "demand costs" is usually the ratio of the customer's individual maximum to the maximum demand on the system. Due to diversity in use, however, it is obvious that any individual maximum demand should be corrected by the use of the diversity factor. A hypothetical illustration can be selected from the field of manufactured gas. If it is assumed that maximum demand on the distribution system is 100,000 cu. ft. hourly and the observed demand of all customers is 300,000 cu. ft. then the diversity factor is 3. If demand costs against an individual customer are to be assessed, on the basis of the ratio of the customer's individual maximum demand to the maximum demand on the distribution system, a customer with a maximum demand of 60 cu. ft. hourly would therefore be assessed 60/100,000 of the demand costs of the company. If all customers were assessed demand costs on this basis, the company, due to the diversity factor of 3, would collect its demand costs threefold. It is necessary in order to make the rate schedule and rates more nearly in accord with conditions encountered, to divide the customer's individual maximum by 3, the diversity factor, and assess against him then 20/100,000 of the demand costs.

Some of these afore-mentioned factors which influence the making of the rate schedule are difficult of determination. It would be difficult, and usually expensive, to measure the demand of each individual customer. The actual measurement of demand is infrequently practiced and then only for the larger customers. In other cases, the demand of a customer is limited to the amount contracted for by means of devices which restrict the flow of the product (gas or electrical energy) to specified

amounts. It is most common, however, to estimate demand on one or more of the following bases: connected load, estimated use of connected load, intermittent measurement of use of connected load, size of meter required, floor area, number of rooms, and the like. None of these estimated bases give more than an approximation of the individual customer's maximum demand. The desirable measurement, if costs are to be correctly assessed against the users responsible, is to measure actual demand in relationship to the peak demand on the system. Diversity factor is likewise difficult to determine. As at present constituted, this item is largely a matter of judgment. It is particularly difficult to determine except for the very largest users and is usually applied to a group or class of customers.

Due to the large number of customers, administrative convenience makes it necessary that the public utility deal with its customers by classes instead of individually. It thus becomes necessary for the public utility to design its rate schedule so that it fixes a rate for each class of customers which recognizes (1) the maximum demand price which the customers as a group will pay, and (2) the costs incurred in serving this group of customers. One therefore usually finds that the rate schedule is designed so that the class of customers with the most intense wants, such as domestic users of electricity, are given the highest rate. Where there are substitute sources of supply, such as gas, or where the customers can supply themselves, as in the case of large power users, the rates carried in the rate schedule will be on a lower basis.[1] It is assumed that the unit costs of serving all customers in the same class are approximately the same, and on this basis it is believed that class rates offer rates which are fair to the customers in each class. The necessity of careful scrutiny in determining classification of customers is obvious. Where classes are determined satisfactorily, the ideal individual rate will not differ materially from the rates for all customers in the class. The public utility company thus is relieved of the obligation of computing a different basic rate for each small customer, and simplicity in rate design is promoted.[2]

[1] GLAESER, MARTIN G., "Outlines of Public Utility Economics," pp. 620–621, The Macmillan Company, New York, 1927.

[2] BARKER, HARRY, "Public Utility Rates," pp. 13–14, McGraw-Hill Book Company, Inc., New York, 1917.

It is not to be assumed, however, that classification of customers invalidates the influence of load factor and diversity factor in determining the rate schedule. Rather, these items are averaged for the whole group of customers in the class. The fixed charges for the peak-load capacity required for all the members in the group is used rather than the fixed charges on the peak capacity required by any one customer. The diversity factor can be applied to a group by application of the following formula.[1]

$$\text{Group maximun} \times \frac{\text{actual peak}}{\text{aggregate group maximun}}$$

One other influence upon the making of the rate schedule should be noted. During the period when the public utilities of this country have shown their most rapid growth, there have been enormous shifts and changes in population, economic organization, and methods of production. Mass production and labor-saving devices are part of our everyday life. Rapid transportation, the growth of the automobile, and improved communication facilities have contributed on the one hand to concentration of manufacturing facilities in urban areas, and on the other hand, to the growth of suburban areas for the homes of a large part of the city population. This has made it necessary that public utility enterprises keep abreast of social changes and constantly plan for the future. Possibilities of growth should be reflected in the rate schedules of the utilities, particularly with reference to the serving of new areas surrounding points already served. Problems of extension, however, will be discussed in more detail in connection with the particular utility enterprises discussed in other chapters. It should be noted, too, that the public utilities can and have contributed to these socio-economic changes. This is particularly true with regard to household labor-saving and comfort appliances. Refrigeration, house heating, water heating, air conditioning, and the like immediately stand out as examples. One of the chief contributions made to these developments has been the establishment of so-called "promotional rates." Motives for the establishment of promotional rates have not been altogether unselfish, the utilities believing that favorable

[1] BARKER, *op. cit.*, pp. 31 *ff*.

loads will be carried by these appliances. Utilizing unused capacity at a rate contributing something more than actual operating costs, a principle made familiar in the "commodity rates" in railroad tariffs, is another expected and often-realized advantage.

A theoretically correct rate structure is one which provides an adequate return to the utility and which assesses the costs of doing business among the customers in proportion to their responsibility for them. For long-run consideration, it should be so devised that it will develop the business, that is, improve the load factor and prevent idleness of the plant and equipment. From the standpoint of the consumer, the rate itself should be reasonable and it should provide for the consumption of increasing amounts of the commodity at comparatively lower prices.

Ideas expressed in the above concept of theoretically correct rates are subject to interpretation. It may be asked: "What is an adequate return?" and "What is a reasonable rate?" It is one of the primary duties of the system of public regulation in the United States to interpret these items and settle disputes which occur between producers and consumers concerning them. The authority of public regulation, therefore, has come to be exerted over public utility rates in such a way that it limits the freedom of the public utility to prescribe whatever rates it sees fit. Without attempting to make an arbitrary disposal of the controversial issues of rate regulation, it can be pointed out that certain standards or tests have usually come to guide the exercise of regulatory authority over public utility rates. To be reasonable to the utility, the rates must be such as will permit the utility to earn:

1. The amount of its actual out-of-pocket operating expenses for labor, materials, administration, repairs, taxes, current retirements, and the like.

2. An additional amount to permit it to create and maintain adequate reserve funds for the recurring retirement of large elements of property not covered by ordinary maintenance, for contingencies and other unforeseeable events.

3. An additional amount to be retained by the owner of the property as compensation for devoting it to public service.[1]

[1] American Gas Association, "Principles of Rate-making for Gas Companies," 1926, Appendix, p. 13.

From the standpoint of the consumer, a just and reasonable rate is one which equitably divides the spread between the cost of the service and the value of the service to the patron. It is assumed, in this statement, that the value of the service is greater than what it costs to produce it. If this assumption were not true, the utility would not be providing an economic service and could not long exist. Also, it is necessary that the rates themselves do not impose unreasonable exactions upon individual consumers. For the protection of consumers, discriminatory rates are prohibited.

Our analysis of the theory and purpose of the rate structure has indicated that due to the fact that most public utilities operate under conditions of monopoly or limited monopoly, the rate structure is the device whereby the costs of doing business are assessed against the users of the product responsible for those costs, the value of the service to the customer or class of customers setting the upper limit to the level of rates which may be established. The primary factors influencing the making of the rate schedule were pointed out to be: (1) The large capital investment with a large proportion of fixed charges in total costs; (2) the need for classification of customers; and (3) the development of the business in a dynamic socio-economic state. While the details of cost analysis were not pursued, it was pointed out that the usual basis for allocating fixed charges against the customer responsible therefor was consideration of peak-load demands and the load factor, as modified by diversity in use. Further details of cost analysis and allocation will be described by taking an illustration from the manufactured-gas industry.

COST ALLOCATION IN THE MANUFACTURED-GAS INDUSTRY

The costs of manufactured gas are materially influenced by the nature of the industry. Artificial gas for lighting, cooking, and domestic and industrial heating is manufactured at a central plant and distributed at low pressures through pipes. In some cases, it is distributed in long mains at high pressures to reducing stations which supply the distribution mains. From the mains, service lines branch off to the premises of a customer with a meter connecting the service line and the customer's piping. It is possible to store gas in some quantity for some period of time, the usual capacity of the storage holder being

approximately one day's supply. It is usual, therefore, for the central plant to manufacture at a uniform rate and send its gas to the storage holders which feed it to the distribution system as needed.

If storage of gas were not practical, it is obvious that the production plant and the distribution system would have to be so constructed that they would be of the same capacity. The capacity of the plant would have to be large enough to permit it to supply the coincident maximum demand of all customers. With storage, the production plant need not be designed to meet instantaneous maximum demand but only the daily maximum demand of its customers. Storage takes up the difference between these two. The distribution plant, on the other hand, must have sufficient capacity to meet the maximum instantaneous demand of its customers. For practical purposes, the capacity of the distribution demand is determined and expressed on an hourly basis.

The demands or needs of the customers, therefore, determine the size or capacity of the plants to be constructed, and capital requirements for the manufactured-gas enterprise are thus directly related to the customers' demands for gas. The size of the manufacturing plant is determined by the expected or probable maximum volume of gas that will be required in any one day, *i.e.*, the total coincident maximum demand of all customers for a day. The capacity of the distribution system is determined by the expected or probable maximum volume of gas that will be required in any one hour, *i.e.*, total coincident maximum demand of all the customers for an hour.

The demand for gas varies in amount from hour to hour, day to day, and month to month. Hourly fluctuations in the demand for manufactured gas may be taken care of by storage facilities in so far as production is concerned, but the capacity of the distribution system must be equal to the maximum hourly demand. Daily and seasonal variations create problems which can be solved only by the development of consumption which will improve load factor. Hourly fluctuations in demand are shown in Fig. 1. In Fig. 2, curve *A* represents present send-out, exclusive of heating load; curve *B* represents heating load of 1,000 customers; and curve *C* represents heating load added to present gas send-out.

Manufactured-gas companies, up to a certain point, reap economies from increasing the scale of operations. This is due principally to the fact that large plants are more economical than small plants, and to the further fact that load factor is

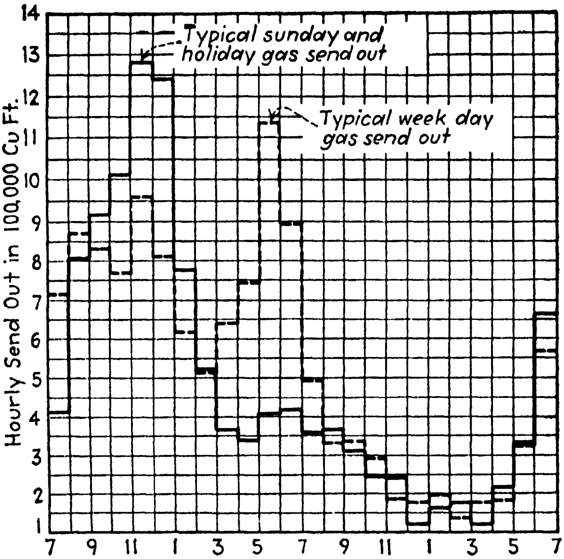

FIG. 1.—Hourly send-out of gas. (*Wilder, E. L., "Off-peak Rate Schedules for Gas," American Gas Association, Proceedings*, 1929, *p.* 721.)

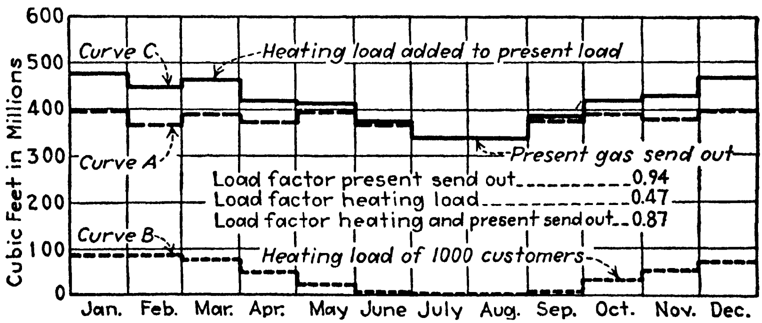

FIG. 2.—Monthly fluctuations in gas send-out. (*Wilder, E. L., "Off-peak Rate Schedules for Gas," American Gas Association, Proceedings*, 1929, *p.* 724.)

improved in large plants. Limiting factors upon the economical size of manufactured-gas plants are the technical difficulties and the costs of distributing gas over great distances. Experiments are being made with large centralized producing plants

which distribute over considerable areas, and it is not beyond reason to expect that gas engineers will be able to develop economical distribution systems for manufactured gas on a scale comparable to those for natural gas.

The total costs of supplying the gas, interest on capital invested, depreciation, and operation, should be described for a manufactured-gas plant as:

1. Production-demand costs.
2. Distribution-demand costs.
3. Customer costs.
4. Commodity costs.

The production-demand costs are those which are required by or related to the size or capacity of the production plant. Some of the items of cost included are interest and depreciation on the investment in the production plant, taxes, and insurance. Some of the production-plant maintenance and repair costs are also included. These interest and depreciation charges accrue from the time that the plant is constructed and remain fixed whether the plant operates at capacity, part capacity, or is shut down. Since the amount of capital invested in production equipment is fixed by the maximum daily demands of all customers, the interest and depreciation costs in the theoretically correct rate should be assessed against each customer in proportion to his individual maximum daily demand. The unit of service covered by the production demand is the readiness of the company to produce 100 cu. ft. of gas in 1 day. Accordingly, these costs can be distributed through the rate structure against a customer on the basis of the proportion that his maximum daily demand bears to the coincident maximum daily demand on the plant.

Distribution-demand costs are those which are made necessary by or are related to the size or capacity of the distribution system. Items included are interest and depreciation on the investment in the distribution system, taxes, insurance, and nearly all of the maintenance expenses of the distribution system. As in the case of the production-demand costs, the costs included in this group do not vary but remain fixed regardless of the volume of gas being distributed. The coincident maximum hourly demand of the customers is thus the factor responsible for these costs. The unit of service covered is the

readiness of the company to deliver 100 cu. ft. of gas per hour. These costs can be correctly distributed through the rate structure to each customer in the proportion that his maximum hourly demand bears to the total coincident maximum hourly demand on the system.

Customer costs include all costs or expenses arising from meter reading, keeping of accounts, adjustment of appliances, and the like. It also includes interest and depreciation on that part of the distribution system which is related to the number of customers served rather than to their hourly demand. To be included in customer costs, the expense must not be related in any way with the quantity of gas taken. Experience has demonstrated that these costs are related to the number of customers so that item becomes the unit whereby these costs are distributed in the rate schedule.

Commodity costs are those which depend upon or vary with the volume of gas produced. Commodity costs are those which arise from production or operation, and include such items as labor, fuel, and materials used in production. Expenses in this group are supposed to originate only as production begins and to cease as production ceases. The service unit covered is the actual number of commodity units produced and is distributed in the rate structure on the basis of each M.C.F. of gas actually taken by the customer.

The above discussion of cost allocation has been in general terms. In actual practice, a company desiring to allocate its costs to these four groups, as the basis for designing the rate structure, would find it necessary to analyze each of its balance-sheet and profit-and-loss-statement accounts in order to properly allocate the items therein to these basic-cost groups. For illustration purposes, the cost allocation as made for a hypothetical company may be shown.[1]

The basic facts about the company are: It operates in a city of 300,000 population, it manufactures carbureted water gas for about one-half of its requirements and purchases coke-oven gas from steel companies for the balance of its requirements.

[1] These data are taken from American Gas Association, "Principles of Rate-making for Gas Companies," Report of the Rate Structure Committee, 1926, Appendix, pp. 26 *ff*. The allocations of expenses as made in this report are used without critical comment.

The cost data and allocations are:

1. Capital investment in plant, distribution system, and equipment, \$12,000,000.
   a. Responsibility for this investment was attributed to:
      (1) Production demand, \$2,858,000 or 23.82 per cent.
      (2) Distribution demand, \$4,490,000 or 37.41 per cent.
      (3) Customer, \$4,652,000 or 38.77 per cent.
2. Analysis and distribution of expenses, both operating expenses and return on fixed capital, using above percentage for the allocation of fixed costs:
   a. Total expenses, \$3,293,024.
      (1) Allocated to the basic-cost groups:
         (*a*) Production demand, \$435,034 or 13.22 per cent.
         (*b*) Distribution demand, \$636,552 or 19.33 per cent.
         (*c*) Customer, \$1,004,963 or 30.48 per cent.
         (*d*) Commodity, \$1,216,475 or 36.97 per cent.

The company's records disclose that it has 76,000 customers and annual sales of 3,150,000 M.C.F. of gas. The maximum 24-hour demand is 12,400,000 cu. ft. and the maximum 1-hour demand is 1,200,000 cu. ft.

With these data, the theoretical rate would be determined as:

1. Production-demand costs, assessed on a basis of 100 cu. ft. of 24-hour demand, \$435,034/124,000 = \$3.516 per year or 29 cents per month.

2. Distribution-demand costs, assessed on a basis of 100 cu. ft. of 1-hour demand, \$636,552/12,000 = \$53.046 per year or \$4.42 per month.

3. Customer costs, assessed on basis of number of customers, \$1,004,963/76,000 = \$13.223 per year or \$1.10 per month.

4. Commodity costs, assessed on basis of amount of gas sold, \$1,216,475/3,150,000 = \$0.3862 per M.C.F.

The theoretical rate structure, without correction for diversity, would therefore be stated as:

\$0.29 per 100 cu. ft. of 24-hour demand per month.
\$4.42 per 100 cu. ft. of 1-hour demand per month.
\$1.10 per month, customer or service charge.
\$0.386 per M.C.F. per month.

Application of this theoretical rate to several customers, showing corrections for diversity, gives the following:

Monthly consumption, cu. ft. (1)	Observed 24-hour demand, cu. ft. (2)	Diversity factor (3)	Assessed demand, cu. ft. (4)	Production-demand costs at 29 cents per 100 cu. ft. (5)	Observed 1-hour demand, cu. ft. (6)	Diversity factor (7)
1,000	75	1.5	50	$0 145	36	6
2,000	120	1.5	80	0 232	60	6
3,000	170	1.3	130	0 377	70	5
4,000	204	1.3	157	0.455	80	4.5
5,000	260	1.2	216	0 626	80	3.5

Assessed demand, cu. ft. (8)	Distribution-demand costs at $4.42 per 100 cu. ft. (9)	Customer costs (10)	Commodity costs at $.386 per M C.F. (11)	Total costs (cols. 5, 9, 10, and 11) (12)	Cost per M.C.F. (13)
6	$0.265	$1 10	$0 386	$1 90	$1.900
10	0 442	1.10	0 772	2 55	1,275
14	0 619	1 10	1.158	3 25	1 083
18	0.796	1 10	1 544	3 90	0 975
23	1 017	1 10	1 930	4 67	0 934

The theoretically correct rate as determined from this cost analysis and allocation assesses the costs against the users or customers in proportion to their responsibility therefor. It also theoretically will return to the company an exactly adequate or fair return. Further reference to this rate will be made as other rate forms are described. To avoid complication, the above allocation of costs was made on the assumption that the gas service was all one class of service. Such an assumption would likely hold true in the case of a company selling gas for domestic consumption only. In most cases, however, the company's service is supplied to several classes of business, each of which differs from the other and each of which has its own distinct load characteristics. An illustrative classification of customers, with the percentage of the total consumption of each class might be: Domestic service, 50 per cent; industrial service, 25 per cent; commercial service (hotels, restaurants, etc.), 15 per cent; and house and water heating, 10 per cent. Due to differences in the use made of the service, analysis will show that the costs of providing the service should be apportioned to each class of service. Then,

the costs of each class should be allocated to the basic-cost groups and distributed through the rate structure to the users of the service in that class.

Classification of customers and the distribution of costs to each class raise another problem. Some costs are caused by and directly related to a given class of service but many of the costs incurred are common to all classes. The economic principle of joint cost is the theoretical basis whereby these common costs are to be apportioned to the several classes of service. Here again inadequacy of data makes it difficult or impossible to apportion costs except on an arbitrary basis. However, the goal of the apportionment of joint costs should be clear; namely, apportionment to the several classes of customers in such a way that the development of the business will result in the greatest good to the greatest number of customers.

RATE FORMS

Theoretically correct, or scientific, rates determined in accordance with the principles above outlined will meet all the requirements of a rate schedule. They will provide adequate revenue, they will assess the total costs of operating the business fairly and equitably among the individual customers, and they will best develop the business. Many public utility industries, notably the gas industry and the electric light and power industry, have made considerable progress towards the general adoption of theoretically correct rates, but so far such procedure has not been wholly expedient. Probably the principal obstacle in the way of such progress has been the fact that in the beginning gas rates and electric rates consisted of one charge, which was a flat charge per month or was based upon the amount of consumption, and attempts to introduce new elements into the total charge encountered the resistance of custom and tradition. In addition, the displacement of flat or meter rates by scientific rates would have increased the bills of a certain proportion of the consumers, and this could not have been attempted without first undertaking a rather broad program of educating consumers as to the justness of such charges. Consequently, there are used today in the gas and electric utilities many rate forms which only, and in many cases remotely, approximate scientifically correct rates. The most important of these rate

forms we shall now discuss in detail. Rates and rate forms for the utilities other than gas and electricity will be discussed separately in succeeding chapters. The illustrations used in the subsequent discussion are of gas rates, but they may be readily applied to rates for electric energy.

1. Straight-line meter rate or flat meter rate. *Example:* $1.50 per M.C.F.

This is the oldest and simplest form of meter rate. In spite of the fact that it makes no recognition of cost allocation, it still is widely used. The chief objection to this type of rate is that the small customers with poor load factors pay less than it costs to serve them. Other customers must, therefore, pay much more than the costs properly attributable to them. It makes no recognition of the influence of each customer in the investment in plant and distribution system and therefore has a chance distribution of production-demand, distribution-demand, and customer costs.

2. Straight-line meter rate with service charge. *Example:* Service charge, $0.50 per month; all gas, $1.35 per M.C.F.

The addition of a service charge, collected regardless of the use of gas by the customer, insures to the company a certain minimum income from each customer. A small service charge is approximately equivalent to the customer costs of the theoretically correct rate. A larger service charge would embody some recognition of the demand costs, though they would be assessed equally on all customers.

3. Step rate. *Example:* (1) Where consumption is under 10,000 cu. ft. per month, $1.55 per M.C.F.; (2) where consumption is over 10,000 cu. ft. but less than 20,000 cu. ft. per month, $1.45 per M.C.F.; (3) where consumption is over 20,000 cu. ft., per month, $1.35 per M.C.F.

The essential feature of the step rate is that all the gas consumed by a given customer is figured at a specified unit price, with a lower unit price being applied to larger quantities of gas. The effect of this type of rate is to give a lower rate to the larger customers. It fails, however, to relate the rate to the demands of the customers and their load factors. As such, it creates unfairness between customers. If one customer has a large consumption resulting from many hours' and many days' use of a relatively low demand and if another customer's large

consumption results from a limited use of his facilities, it is obvious that the high demand of the latter is not recognized. Such a customer is given the benefit of a low rate while he has actually caused the company to incur large fixed costs for the production and transmission equipment provided to serve him and which he uses only a limited time. A second objectionable feature of the step rate is that in many instances the total charge for a small quantity of gas is greater than the total charge for a larger quantity. This can occur with consumption figures slightly less than the specified amount for the transition to a lower step rate. As such, many customers will waste gas in order to bring their total consumption just into the next higher step. This latter objection can be partially overcome by a provision in the rate schedule to the effect that the charge shall never be less for a larger consumption than for a smaller one. A merit of the step rate is that it tends to promote larger usage of gas and thereby to improve the company's load factor.

4. Block rate. *Example:*

First	10,000 cu. ft.	at $1.55 per M.C.F.
Next	20,000 cu. ft.	at $1.20 per M.C.F.
Next	70,000 cu. ft.	at $1.10 per M.C.F.
Over	100,000 cu. ft.	at $0.90 per M.C.F.

The essential feature of the block rate is that the charges against a customer are figured at a specified unit rate for specific quantities of consumption. The unit rate is less for the larger blocks of consumption. As in the case of the step rate, this type of rate structure promotes larger use of gas. It overcomes one weakness of the step rate in preventing the payment of a larger sum for a smaller consumption of gas. The other weakness of the step rate—discrimination between customers—is not prevented by the block rate in that, as in the step rate, no recognition is made of customers' demands and the use made of the facilities.

A minimum charge is often added to this rate, which allows the customer a given quantity of service for a specified amount. It is introduced as a means of providing for the customer charge of the theoretically correct rate. It provides that each customer pays a certain minimum amount monthly regardless of his further use of gas. Like the straight block rate, however, it

makes no recognition of customers' demands and therefore does not prevent discrimination between customers. It is also possible to provide for a service charge in conjunction with the block rate.

5. Demand rates. *Example:* Demand charge, 4 cents per cu. ft. of maximum hourly demand; commodity charge, 80 cents per M.C.F.

This type of rate consists of two charges. The demand charge is applied to the actual or estimated maximum hourly demand of the customer, and so long as a customer's service outlets remain unchanged, the demand charge remains fixed and is collected each month regardless of whether any use is made of the service. The demand charge distributes roughly the distribution-demand costs against those consumers who are responsible for them. The commodity charge, a flat meter rate, is assessed against the actual consumption by the customer. In effect, therefore, the charge per unit decreases as the consumption increases since the demand charge is spread over a larger number of units of gas. This type of rate thus tends to promote an increase in the use of gas.

In the assessment or distribution of the distribution-demand costs, this rate type is an improvement over other types. Its chief weaknesses are three: (1) It does not take into consideration the costs arising from variation in the 24-hour demands or, as we have called them, the production-demand costs. (2) Unless the demand charge per cubic foot of maximum hourly demand is relatively high, it does not cover the customer costs of the theoretically correct rate. Another way of including customer costs would be to add a service charge. But in either event, the amount of the charge without any use of the service at all would be high and customer ill-will would be engendered. It is possible, too, that customers would turn to competitive service such as electricity. (3) Since the customers are assessed a charge against their maximum hourly demands, there is an incentive to cut down the number and size of their service outlets, thereby reducing the demand charges assessed against them. The two charges in this type of rate were illustrated as flat charges. In general application, it should be noted, both the demand and the commodity charges can be stated as block rates.

6. Three-part rates. *Example:* (1) Customer charge, $12 per customer per annum, payable in 12 monthly installments; (2) demand charge, $22 per 100 cu. ft. of maximum hourly demand per annum, payable in 12 monthly installments; (3) commodity charge, 80 cents per M.C.F.

The three-part rate adds to the demand and commodity features a customer charge, which is the only essential difference from the demand rate described above. Hence, this type of rate has similar advantages and disadvantages. It does, however, more closely approach the theoretically correct rate, failing to consider only the production-demand costs. The block-rate principle can be used in stating the demand and commodity charges of this three-part rate.

7. Wright demand rate. *Example:*

First 30 hours' use per month of active load, $1.35 per M.C.F.
Next 30 hours' use per month of active load, $1.00 per M.C.F.
Over 60 hours' use per month of active load, $0.70 per M.C.F.

The active load of each customer using this type of rate must be determined. As an illustration, range burners may be assigned an active load of 15 cu. ft. with a minimum of 60 cu. ft. per range. Continuous-storage-type water heaters may have about 10 cu. ft. active load, and automatic-storage-type water heaters about 30 cu. ft. of active load. It is frequently provided that this rate is not available except for specified uses, or for a specified active load, say 70 cu. ft.

This type of rate, named after its originator and first applied in the electric light and power field, takes into account the customer's load factor and carries a charge related to the demand made by the customer on the distribution system. It gives to the customer the benefit arising from a full use of his active load in that the unit cost decreases as consumption, in relation to active load, increases. To illustrate: Customer A has an active load of 70 cu. ft. and consumes 7,000 cu. ft. during a given month. His bill for that month will be:

First 30 × 70 =	2,100 cu. ft.	at $1.35 per M.C.F.	$2.84
Next 30 × 70 =	2,100 cu. ft.	at $1.00 per M.C.F.	2.10
Remainder	2,800 cu. ft.	at $0.70 per M.C.F.	1.96
Total	7,000	Total bill	$6.90

Average cost per M.C.F. $0.9875.

Customer B, with an active load of 140 cu. ft. has the same consumption, 7,000 cu. ft. His bill will be:

First 30 × 140 = 4,200 cu. ft. at $1.35 per M.C.F. $5.67
Next 30 × 140 = 4,200 cu. ft. of which only
2,800 are used at $1.00 per M.C.F. $2.80

Total bill $8.47

Average cost per M.C.F., $1.214.

It is apparent that this type of rate favors those customers who make the fuller use of their active load and rightfully assesses distribution-demand costs against customers with a high demand who use it only to a slight extent. While appearing complicated, this type of rate is in reality simple to apply. It is not complicated to the customer since only the one charge appears on his bill.

8. Flat demand rate. *Example:* Appliance, such as a water heater, with a rated capacity of 7 cu. ft. per hour, a flat charge of $2 per month; appliance, such as a refrigerator, with a rated capacity of 3 cu. ft. per hour, a flat charge of $1.30 per month.

Under this type of rate, there is a flat monthly charge depending upon the capacity of the gas-burning equipment installed on the customer's premises. There is no additional charge for gas consumed. It is quite obvious that this type of rate schedule can be made applicable only to those appliances which are in almost constant or steady use. In such cases, its simplicity has much to commend it.

9 Therm rate. *Example:*

Commodity charge—First 25 therms, 30 cents per therm.
Next 450 therms, 22 cents per therm.
Over 475 therms, 18 cents per therm.

As in other types of rates, a service charge payable monthly can be quoted in connection with the commodity charge. Therm rates frequently provide also that there will be a minimum monthly charge, of say $5 per month.

The use of a therm rate is an attempt on the part of a company to assess its charges on the basis of heating value or thermal content of the gas used by a customer. As such it represents quoting rates in terms of heat content instead of cubic feet

of consumption. Since manufactured gas varies between 400 and 1,000 B.t.u. per cubic foot, depending upon how manufactured and how mixed, rates quoted in therms are more comparable than those quoted in cubic feet.

A therm is a unit of heating value equivalent to 100,000 British thermal units. A B.t.u., in turn, is a measure of the heating value of gas and may be defined as $\frac{1}{180}$th of the quantity of heat required to raise the temperature of 1 pound of water from 32 to 212°F. The number of therms in a given volume of gas is determined by multiplying the given number of cubic feet of gas by the average heating value of the gas in B.t.u. per cubic foot and dividing this product by 100,000. For instance, 1,000 cu. ft. of gas having an average heating value of 550 B.t.u. is the equivalent of 5.50 therms.

The use of demand-rate schedules, carrying an assessment of demand costs against the users responsible, is becoming more general in the gas and electric utilities. The use of these types of rate schedules looks to four results, beneficial to both consumer and producer. These have been stated for the gas industry, as follows:[1]

1. Protection. Experience with rate schedules has demonstrated the desirability of types which take into account the cost of service. When so constructed, the rate schedule meets the conditions under which gas is served and tends to encourage increased consumption, thereby improving the ratio between capacity and average daily output. Rates can thus be held down to a low level or the level of the rates might be lowered.

2. Correction. It is now estimated that many companies serve from 30 to 80 per cent of their customers at a loss. In order to receive a fair return, this loss must be recouped from higher charges on the remaining customers. Rate schedules based on cost eliminate this kind of discrimination.

3. Inducement. The cost basis of rate schedules gives lower per-unit charges for increased consumption. They thus promote increased use of the service.

4. Attraction of additional business. Some industrial uses of gas make use of gas through the working hours of the day and the year at a higher load factor than in domestic uses. The latter class frequently has a seasonal peak load. If larger

[1] American Gas Association, "Better Forms of Rates for Gas," p. 11.

sales are stimulated in industrial uses, the increased volume of sales tends to lower certain costs and thereby permits lower rates to all customers.

The correction of discrimination is often beclouded by false claims. The 30 to 80 per cent of the customers served at a loss are those who consume only small quantities of gas. In view of this, eloquent pleas can be made to the effect that the small user is the "poor man" and that it is desirable that his rates be low, even if he causes a loss to the company. The error of this claim can easily be seen. Under typical conditions, the so-called "poor man" is a relatively heavy user of gas, for cooking, heating, laundry at home, and the like. Moreover, his use is practically constant throughout the year. In relation to his demand, his use frequently presents a high load factor. The small user, on the other hand, is most likely to be the professional office (doctor and dentist), cigar store, lodge hall, or tenant of an apartment with high rental. In this latter case, there is no space or water heating by the tenant, laundry is probably sent out, and cooking is at a minimum, with no use at all during many days of the summer and winter. To make consumers of this class pay their way does not burden the typical "poor man."[1]

Attraction of additional business is being more widely attempted in the manufactured-gas industry. Favorable results attained in the electric light and power industry have pointed to the desirability of attracting more business. In the first instance, improvement in the load factor, *i.e.*, greater utilization of plant and equipment, has resulted in lowering the per-unit cost of the output. In the second place, larger-size production and transmission facilities have been installed, with the resulting economies of large-scale production accruing to the benefit of the industry. In the manufactured-gas industry, both these general benefits can arise from increased business. In general, fuller utilization of the existing plant is the benefit obtained.

The primary means of obtaining additional business is through the use of so-called "promotional" and "off-peak" rates. Promotional rates are those which are offered to induce consumers to install a new service, such as space heating, or to induce new industrial uses. In either case, the comparative lowness of

[1] *Op. cit.*

the rate is expected to be offset by the returns accruing from a greatly increased consumption. Off-peak rates, on the other hand, are rates offered to users of the service at off-peak hours, with usage usually limited to such hours.

On the face of the matter it would seem that off-peak rates could have but limited use. Analysis of the nature of the peaks occurring, however, will indicate that off-peak rates might attract a substantial volume of business. The improvement in the company's load factor, and the fact that little or no additional investment in plant and distribution system is required, make it evident that such business is desirable so long as it returns more than its commodity and customer costs.

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CHAPTER III

THE GAS INDUSTRY

THE MANUFACTURED-GAS INDUSTRY

Manufactured gas was first discovered by Jan Baptista van Helmont of Brussels, about 1609, but it was not until the early part of the nineteenth century that it came into commercial use. During the intervening two centuries many experimenters developed scientific principles and apparatus which laid the foundation for the industry. Dr. John Clayton, an English clergyman, manufactured coal gas in a series of experiments during the years 1660 to 1670, and about a century later Professor Jean Pierre Minckelers of the University of Louvain illuminated his lecture room with coal gas. In 1792, William Murdoch succeeded in lighting his home in Redruth, Cornwall, by coal gas. Later, in 1798, he lighted the factory of Boulton, Watt and Company with gas, and in 1804, the cotton mills of Messrs. Phillips and Lee at Manchester, the latter installation using 900 burners. In 1804, Frederick Winsor received the first English patent for the manufacture of artificial gas, and it was his work, he being an ardent promoter as well as an inventor, which led to the formation of the world's first chartered gas company incorporated in 1810 as the London and Westminster Gas Light and Coke Company, and granted a royal charter in 1812.

Manufactured gas was first introduced into the United States in 1806 when David Melville, of Newport, Rhode Island, lighted his house with gas. The first commercial gas company was organized in Baltimore in 1816, and the second in Boston in 1822. These were followed by companies in New York in 1823 and in Brooklyn, Bristol, Rhode Island, and New Orleans in 1835. Early commercial development was hampered by opposition of all sorts. Philadelphia, for example, because of the odor of gas refused until 1836 to grant a franchise to a gas company. Other objections were based upon theological, medical, and moral

grounds. So slowly did development take place that by 1850 there were only about 30 plants in the United States, with estimated capitalization of $7,000,000, and annual gross revenues of about $2,000,000.[1]

During the first half of the nineteenth century manufactured gas was used mostly for street lighting, but in the latter half of the century many other uses were developed. The lighting of auditoriums, and other public buildings, places of business, and residences of the wealthy soon developed and these were followed by general residence lighting. However, residence lighting by gas was only getting well established when it had to meet the competition of the cheaper kerosene lamp, introduced in 1865. Then came electric lighting. Beginning about 1878, it rapidly displaced gas for lighting purposes. The Welsbach mantle, invented in 1885, saved some of the lighting business for gas for a time but eventually electricity took away practically the whole lighting load, gas companies having largely relinquished lighting to electricity by 1915.

Manufactured gas was not used extensively for fuel until near the end of the nineteenth century. In 1850 Bunsen invented the injector-type burner which gave a more intense heat without the smoke nuisance and with less gas consumption. The next year gas cookers for inns and eating places were exhibited, and about 1859 gas was first used for domestic cooking. Gas stoves and heaters did not appear until much later, cooking being done first on a single-burner hot plate, then a two-burner, and later ovens were placed on top the burners. By 1900, however, gas ranges were in general use and the manufactured-gas industry, threatened almost by extinction with the loss of its lighting load, entered a new era of prosperity with domestic cooking and heating as its base load.

The early development of the manufactured-gas industry was retarded greatly by excessive costs of manufacture, due to the crudity of the processes and the high costs of transporting materials and supplies. The price of gas in New York City, for example, was $10 per M.C.F. in 1826, and was still $6 per M.C.F. in 1846, as compared with $1 some 50 years

[1] MAAS, W. G., Economic Development of the Gas Industry, in H. B. Dorau, "Materials for the Study of Public Utility Economics," pp. 1–5, The Macmillan Company, New York, 1930.

later.[1] A discovery of great importance in reducing the costs of manufacturing gas was that of the process of making water gas, discovered independently by DuMotay, a Frenchman, and Lowe, an American. Water gas is made by passing steam through incandescent coke or anthracite. It has a low calorific value but there soon developed the process of enriching it with oil gas, made by gasifying oil, thus forming carbureted water gas. The first water-gas plant was established in Phoenixville, Pennsylvania, in 1873, and although opposed by coal-gas manufacturers, the manufacture of water gas spread rapidly until it became the principal type produced. Another development which tended to reduce manufacturing costs was the perfection of the coke-oven process of steel manufacture, gas being obtained cheaply as a by-product. Such gas was purchased by manufactured-gas companies wherever available. These processes not only led to increased domestic use of manufactured gas, but to many industrial uses. Other developments in the manufacture of gas will be discussed more fully later.

The manufactured-gas industry grew from the 30 companies in 1850, previously mentioned, to 1,019 companies in 1905, with a capitalization of more than $725,000,000, and 1,022 companies in 1919, with a capitalization of $1,465,658,265.[2] Since 1919 an outstanding development has been the formation of combinations of gas companies with the interconnection of mains and the concentration of gas production in large efficient plants. In 1919 there were 1,300 manufactured-gas plants in operation in the United States but by 1929 the number had decreased 45 per cent to 715. These combinations have involved manufactured-gas plants in the same town, in adjacent towns, and in widely separated towns.

The output of manufactured gas grew continuously from the beginning until 1930, as did the number of customers served. Total sales of gas to customers increased slowly until 1870, then more rapidly until 1905 with the lowering of costs of manufacture and increased domestic consumption for cooking and heating. From 1905 to 1915 the rate of increase was still

[1] Dawes, A. C., *Proceedings of the Investment Bankers Association*, 1914, p. 182, quoted in Jones, Eliot and T. C. Bigham, "Principles of Public Utilities," p. 11, The Macmillan Company, New York, 1931.

[2] "Biennial Census of Manufactures," 1921.

more rapid due to the fact that industrial customers were added in great number, although this rate was slowed down somewhat by the rapid increase in the use of natural gas during this period. The most rapid increase occurred during the years from 1915 to 1929. Sales of manufactured gas to customers increased from 204,310 million cubic feet in 1915 to 524,115 million cubic feet in 1929, an increase of 156 per cent. During the same period the total number of customers increased from 7,300,000 in 1915 to 12,139,000 in 1929, or 66 per cent. The increased consumption per customer was due to the very great increase in the number of large commercial and industrial consumers during that period. From 1901 to 1929 sales to customers increased more than fivefold. Since 1929 there has been a decline, sales to customers amounting to 522,853 million cubic feet in 1930 and to 391,197 million cubic feet in 1931. The latter figure is not wholly comparable, however, since it does not include the sales of companies formerly distributing manufactured gas but which were distributing natural gas at the beginning of 1931. Deducting the sales of those companies from the totals for the years 1930 and 1929 the decline in 1931 was only 3 per cent from 1930, and only a little more than 2 per cent from 1929. Sales during 1930 were held up partly by a 28 per cent increase in the sale of gas for house-heating purposes, the over-all decline being due to the falling off in industrial and commercial consumption. In 1931, sales for domestic purposes, other than house heating, declined 2 per cent, while industrial and commercial sales declined 7.4 per cent. In 1932, sales of manufactured gas declined 8 per cent from the previous year, sales for domestic uses, other than house heating, declining 5 per cent, industrial and commercial sales 20 per cent, and sales for house heating 1 per cent. The downward trend of manufactured-gas sales continued in 1933, with a decline of 4.7 per cent from 1932. Sales for domestic uses, other than house heating, declined 6.9 per cent, although industrial and commercial sales were approximately the same as the year before, while sales of manufactured gas for house-heating purposes were 5.3 per cent above 1932. In 1934 the decline in total sales of manufactured gas was arrested, total sales for that year being 347,453 million cubic feet, or 4 per cent above those of 1933. This increase was due to outstanding increases in the sales for house heating and for industrial and commercial uses,

the former increasing 40.1 per cent, and the latter, 15.9 per cent. Sales for domestic uses declined 2.7 per cent from 1933. The growth in number of customers and the volume of sales from 1901 to 1930 are shown in Table 1.

TABLE 1.—MANUFACTURED-GAS INDUSTRY IN THE UNITED STATES
Customers served and annual gas sales 1901–1930

Year	Total customers	Sales of gas, in M.C.F.	Year	Total customers	Sales of gas, in M.C.F.
1901	4,200,000	101,625,000	1916	7,600,000	231,381,000
1902	4,280,000	92,715,000	1917	7,900,000	264,493,000
1903	4,360,000	105,676,000	1918	8,200,000	271,593,000
1904	4,440,000	113,930,000	1919	8,484,000	300,000,000
1905	4,520,000	112,444,000	1920	8,837,000	319,888,000
1906	4,600,000	122,850,000	1921	9,200,000	326,951,000
1907	4,875,000	132,012,000	1922	9,400,000	350,000,000
1908	5,150,000	138,570,000	1923	9,800,000	384,722,000
1909	5,425,000	143,118,000	1924	10,200,000	405,200,000
1910	5,700,000	149,431,000	1925	10,600,000	421,400,000
1911	6,020,000	159,101,000	1926	11,047,000	455,631,000
1912	6,340,000	178,229,000	1927	11,450,000	471,000,000
1913	6,660,000	188,286,000	1928	11,848,000	495,020,000
1914	6,980,000	198,839,000	1929	12,139,000	524,115,000
1915	7,300,000	204,310,000	1930	12,134,000	522,853,000

Source: American Gas Association, *Statistical Bulletin* 9, 1931, p. 32.

Production of Manufactured Gas.—As an outgrowth of technical developments in the manufactured-gas industry many gas-making processes have been developed and several are in common use today. There is no one gas which is exactly suitable for all purposes, and none that can be produced with equal economy under all sets of conditions. Consequently, the type of gas to be manufactured in a given locality is chosen after a consideration of many diverse factors, technical as well as economic. The following are the types of gas generally produced in the United States in the order of their importance: water gas, coke-oven gas, retort coal gas, oil gas, reformed-oil-refinery gas, and butane-air gas.

Water Gas.—Water gas is made by taking advantage of certain chemical properties of water, which later in the form of steam react with incandescent carbon, yielding a gas that is

essentially carbon monoxide and hydrogen. It is made by passing steam through incandescent coke or anthracite. It is not used in this form but is enriched by adding oil gas, a product resulting from the cracking of oil, to make carbureted water gas. The advantages of water gas are: the low initial investment per unit of daily gas-generating capacity; the ease with which the equipment can be put into operation and shut down; the ease with which the calorific value can be controlled; the small amount of mechanical equipment requiring considerable attention and repairs; the low labor requirements for gas generation; the relatively low-cost fuel; the fact that the enriching material can be handled readily and cheaply; and that different kinds of solid fuel can be used in its generation.

It has the following disadvantages: there is an increased hazard occasioned by the storage of oil; a dependence upon the availability of low-priced gas oil for economic production; and a limited flexibility in production in that only certain kinds and grades of oil are suitable for carbureting water gas under present conditions. Production of carbureted water gas amounted to 156,625 million cubic feet in 1934 which constituted 62.5 per cent of all gas produced in the United States by manufacturing-gas companies. Since 1920 its relative proportion of the total has declined, due principally to the increasing proportion of coke-oven gas manufactured or purchased by gas companies.

Coke-oven Gas.—Coke-oven gas is a by-product of the manufacture of coke. Formerly in the manufacture of coke no consideration was given to the tar and gas produced in this manner, or to their recovery. Today, however, the coke oven is used successfully not only to manufacture coke but to manufacture city gas. Coke-oven gas was relatively unimportant before 1915 but since that time there has been a steady increase in the amount produced and purchased by manufactured-gas companies. In 1934 coke-oven gas produced by utilities amounted to 53,466 million cubic feet, or 21.3 per cent of the total production. At the end of the year there were 21 such plants operated by 19 utilities. During 1934, manufactured-gas companies purchased 92,134 million cubic feet of coke-oven gas from outside companies, about 24 per cent of the total amount produced and purchased. At the end of the year there were 34 outside plants supplying coke-oven gas for distribution by gas utilities, 20

connected with the iron and steel industry, and 14 operated by merchant coke companies.

Retort Coal Gas.—Retort coal gas is made through the carbonization of coal in horizontal or vertical retorts. Coal is charged into the retorts which are sealed to exclude the air and the temperature is raised to 1250, 1400, or 1800°F. The only outlets from the retorts are the pipes which lead off the gas. The coal coming into contact with the hot retort first fuses and then "boils," and in "boiling" gives off the gas. Different coals may be used in these processes as in those connected with the production of coke-oven gas, but bituminous coal of one type or another is mostly used. Anthracite and lignite are seldom used because the former is a natural coke from which most of the volatile gases have already been driven off, and the latter contains large proportions of oxygen and water. Since 1927 there has been a marked decline in the quantity of retort coal gas produced. In 1934, it amounted to 11.8 per cent of the total gas produced by manufactured-gas companies.

Oil Gas.—Oil gas results from the cracking of oil into simpler hydrocarbons and hydrogen. Its generation is usually accompanied by the formation of "lampblack" and tar in amounts that vary with changes in certain operating variables. It has the advantages that the generators may be put into operation and shut down on short notice; that gas-making capacity is large per unit of ground space occupied by the generators; that operation and maintenance are simple with a small amount of labor; and that the calorific value of the gas can be easily controlled. On the other hand, its production is dependent upon the availability of large quantities of cheap oil of particularly good quality, some of which must be stored on the property; and there is a low gasification efficiency. Oil gas in 1934 constituted only 1.2 per cent of the total manufactured by gas utilities.

Reformed-oil-refinery Gas.—Reformed-oil-refinery gas is a leaner gas than natural gas made from the latter by cracking. This gas has properties which allow its blending with manufactured gas in a wide range of proportions. It was largely because of the need for manufactured gas to augment supplies of natural gas during certain seasons of the year that reformed gas was introduced into the West, where it has been used extensively.

The process involves first heating the generator by burning gas or oil therein in the usual manner and then introducing natural gas in a continuous stream with or without steam. The products of this cracking operation are removed in the same manner as with oil gas. Reformed-oil-refinery gas in 1933 constituted 1.9 per cent of the total gas manufactured by utility companies.

Butane-air Gas.—Butane and propane, which have similar qualities, are found in nature comprising a very small percentage of the natural gas and the natural gasoline from which they are separated. More will be said later concerning their production. Formerly these products were unimportant commercially, but in recent years they have come into considerable use and developments in the oil-refining industry indicate that appreciable quantities of them will be produced in the future. Propane is a gas at all temperatures and pressures at which city gas is usually distributed, but butane becomes liquid at normal temperatures under a few atmospheres pressure. These products, therefore, are not pumped into long natural-gas transmission lines because they would condense in the mains as liquid at the high pressures used there, although some are transported over short distances through pipe lines. They are liquefied and transported in steel containers from which practice has been derived the named "bottled gas."

The amount of "bottled gas" produced by manufactured-gas companies in 1934 was only 0.3 per cent of the total production, but there has been a rapid increase in its use by gas utilities in recent years. Butane may be used as an enricher of natural gas after the losses caused by long-distance transmission, and as a carbureting material in the place of oil gas. It may be shipped into small towns for use in mains, and into suburban and country homes for cooking and heating, where gas mains would be uneconomical. Also, where gas utilities find it difficult to extend their service areas rapidly enough to cover suburban developments, "bottled gas" may be supplied to prospective customers to hold the territory for gas until the laying of mains becomes economical. In the industrial field it bids fair to offer real competition to manufactured gas since it is a by-product of the oil industry, produced incidentally to the manufacture of other products, and can be sold at a fairly low price. It can be shipped from the oil fields to the user's plant in tank cars,

TABLE 2.—MANUFACTURED-GAS INDUSTRY IN THE UNITED STATES*
Gas produced and purchased by the industry for distribution to consumers, 1929–1934
(Unit: M.C.F.)

Gases	1934	1933	1932	1931	1930	1929
Gas produced:						
Water gas	156,625,000	152,957,000	170,499,000	190,635,000	205,856,000	213,549,000
Coke-oven gas	53,466,000	51,366,000	49,267,000	56,266,000	50,839,000	48,814,000
Retort coal gas	30,016,000	29,534,000	32,084,000	38,043,000	40,070,000	41,118,000
Oil gas	3,176,000	3,607,000	4,017,000	4,287,000	4,739,000	4,846,000
Reformed-oil-refinery gas	4,781,000	4,593,000	4,705,000	4,478,000	2,205,000	646,000
Reformed natural gas	1,985,000	947,000				
Butane-air gas	859,000	670,000	519,000	514,000	89,000	10,000
Propane gas		2,000				
Pintsch gas	1,000	1,000				
Total gas produced	250,909,000	243,677,000	261,091,000	294,223,000	303,798,000	308,983,000
Gas purchased:						
Coke-oven gas	92,134,000	86,977,000	92,424,000	109,456,000	118,464,000	114,944,000
Oil-refinery gas†	2,541,000	2,809,000	1,743,000	1,473,000	2,009,000	2,176,000
Natural gas	41,122,000	33,691,000	27,158,000	6,427,000	1,968,000	1,578,000
Total gas purchased	135,797,000	123,477,000	121,325,000	117,356,000	122,441,000	118,698,000
Total gas produced and purchased	386,706,000	367,154,000	382,416,000	411,579,000	426,239,000	427,681,000

* Companies formerly distributing manufactured gas but which were distributing natural gas at the beginning of 1934 have been excluded from the above tabulation for all six years. The data shown above for 1929 to 1934 are therefore not comparable with data on the manufactured-gas industry previously issued for those years.

† Does not include quantity used in production of reformed-oil-refinery gas.

Source: A. G. A., *Statistical Bulletin* 17, 1935, p. 8.

can be stored readily, and can be used by an industrial concern without much additional equipment. In some instances such competition has already become serious, and as time goes on the gas utilities are likely to find increasingly severe competition from this source as well as from other refinery gases, unless they are able to absorb the production and employ it in their systems. In 1933, about 143 towns were served with liquefied petroleum gases, either by butane-air plants or by the distribution of undiluted propane vapors through pipe lines. A summary of recent trends in manufactured-gas production is shown in Table 2.

Consumption.—The bulk of manufactured-gas consumption is by domestic consumers. Of 347,453,000 M.C.F. sold to consumers in 1934 by manufactured-gas companies, 232,829,000 M.C.F., or 67 per cent, was sold to domestic consumers, exclusive of house heating, sales for the latter purpose amounting to 28,551,000 M.C.F., or 8.2 per cent. Together domestic uses accounted for 75.2 per cent of the total gas sold to consumers. Industrial and commercial customers consumed 84,005,000 M.C.F., or 24.2 per cent of the total, and there was sold for miscellaneous uses 2,068,000 M.C.F., or 0.6 per cent of the total. Table 3 shows the number of manufactured-gas customers at the end of 1934, the gas sales to consumers during the year,

TABLE 3.—STATISTICS OF THE MANUFACTURED-GAS INDUSTRY 1934

Class of Service	Gas customers at end of year	Gas sales to consumers, M.C.F.	Revenue from sales to consumers	Annual gas sales per customer, M.C.F.	Annual revenue per customer
Domestic......	9,311,000	232,829,000	$288,420,000	25.0	$ 30.98
House heating.	117,000	28,551,000	19,074,000	244.0	163.03
Industrial and commercial..	437,000	84,005,000	65,871,000	192.2	150.73
Miscellaneous..	9,000	2,068,000	1,480,000	229.8	164.44
	9,874,000	347,453,000	$374,845,000	35.2	$ 37.96

Source: A. G. A., *Statistical Bulletin* 17, 1935.

revenue from sales to consumers, the annual sales per customer, and the annual revenue per customer.

Domestic.—The principal domestic use of manufactured gas is for cooking purposes. This accounts for more than 70 per cent of the domestic revenues, and consequently more than 50 per cent of all revenues from manufactured gas sold to consumers. For many years gas companies had this field practically to themselves, but in recent years electricity has been furnishing keen competition. Electric ranges in use increased from 480,000 in 1926 to more than 1,000,000 in 1933, as compared with about 15,000,000 gas ranges in service. Gas for domestic cooking faces its most serious competition in districts where electricity is generated on a large scale from hydroelectric plants. Competition from steam-electric plants is not so severe. In natural-gas areas, where gas is low in price, electricity is at a decided disadvantage, although some electric ranges have been sold in such areas. Relative advantages and disadvantages of cooking by gas or electricity resolve themselves mostly into a matter of the likes and dislikes of customers, gas being superior in some respects and electricity in others. Probably the principal deciding factor is that of relative cost.

A second important item in domestic consumption is water heating. The greatest competitor of manufactured gas in this service is the coal stove or furnace, which though more troublesome and dirty has advantages of lower operating costs. Oil is also a competitor, as is electricity. So far manufactured gas, and especially natural gas, have had a distinct cost differential in their favor as compared with electricity. However, this differential has been reduced, if not eliminated, in some sections by the introduction of off-peak electric rates for water heating, it now being possible to convert low-cost electric energy into hot-water heat which can be stored in insulated tanks for many hours without appreciable loss. Manufactured-gas companies have been alive to this competition and have responded with lower rates for water heating.

Other domestic uses are for small household appliances and refrigeration. Refrigeration is a new field for gas, although it has met with considerable success during the past few years in competition with electric units. At the beginning of 1934, there were more than 150,000 gas refrigerators in use.[1]

[1] *American Gas Journal*, May, 1934, p. 125.

House Heating.—House heating by central gas-designed heaters has developed to a limited extent among the wealthy because of instantaneous heat and the saving of trouble, but the cost prevents more general use of gas heaters in competition with coal, oil, and other cheaper fuels. In the field of space heating manufactured gas has received a considerable development and many look upon this as the largest market for the future expansion of domestic gas service. Space heaters are all heaters, other than central heating plants, used for heating one room or a section of a home. Space heaters formerly were promoted mostly by natural-gas companies; manufactured-gas companies because of high operating costs were not much interested. The principal active competitor of the gas space heater has been the porcelain-enameled coal-fired circulator, annual sales of which rose from 30,000 units in 1924 to 522,000 in 1929. It is estimated that 50 per cent of those sold were to customers having gas service.[1]

Studies indicate also that the coal circulator furnishes considerable competition in natural-gas districts. Other competitors are the oil-burning space heaters, and conversion oil burners in coal heaters. Some executives are not very desirous of developing house-heating load because of the wide range in seasonal, daily, and hourly fuel demands, since the consumer will not contract to take a specific amount of gas at a definite time but will expect to get all the gas he needs and to use it as he needs it. However, others feel that much valuable load can be obtained in this field. Recently introduced low rates for house heating by certain gas companies would indicate that the load is worth while. These rates apply to the heating of houses and buildings solely by gas for any contract year either by space heating or by approved central installations. Recent estimates of the number of gas-fired space heaters in use place the figure at about 5,000,000.

Commercial and Industrial.—Commercial and industrial use of manufactured gas showed a continually rising trend from 70 billion cubic feet in 1919 to 163 billion cubic feet in 1929. Hotels and restaurants use manufactured gas extensively for cooking and it is used also in baking, roasting, smoking, and other

[1] Circulating Space Heaters, subcommittee report, A. G. A. *Proceedings*, 1932, pp. 494–510.

operations in the preparation of foods. In industry gas is used for firing kilns to make high-grade tableware, and enamelware for cooking and storing food; for the annealing of brass and other metals; for heat treating and forging steel; for refrigeration, drying, and other processes. In many of these, gas, whether manufactured or natural, because of the ease with which the amount of heat may be controlled and other advantages, has no real competitor, although in others it is subject to the competition of coal, fuel oil, and electricity. Changes in the price of competitive fuels, where conversion can be made at slight cost, affect materially the industrial demands for gas. An industrial load is usually an economical load for the gas companies, but the relatively high cost of gas as a fuel restricts it from many industrial processes. However, here is an immense field for gas engineers and research men to develop new uses for their product. A few new uses that seem to be just around the corner from a commercial standpoint are commercial refrigeration and summer air conditioning in public buildings and in homes.

THE NATURAL-GAS INDUSTRY

Natural gas has been in use in the United States for more than a century, but it has been only with the discovery of huge new resources and the development of long-distance transportation in recent years that the industry has attained national prominence. Formerly, while the value of natural gas as a fuel was recognized, the industry was considered of only local economic importance. Today natural gas is distributed in most of the states and in the District of Columbia.

Production of Natural Gas.—Natural gas is produced directly from wells drilled for that purpose, or in conjunction with the production of petroleum. Natural gas and petroleum are formed in the same manner, and although from certain deposits only natural gas is recovered, the two are mostly found together. Today it is estimated that between 60 and 70 per cent of natural-gas deliveries consist of gas which has been produced along with petroleum. The production of natural gas and petroleum are even more intimately related. It has been discovered that natural gas acts as a propulsive agent in the production of petroleum, and that the waste of natural gas in many instances results not only in the dissipation of this resource but failure to

recover a portion of petroleum deposits. For a long time the natural gas brought to the surface in oil fields was wasted, but the increasing commercial importance of this product has tended to stimulate its conservation. States alive to the value of such resources have aided in their conservation by the enactment of laws which require the recovery of natural gas produced jointly with petroleum.

Natural gas falls into two general classifications: dry gas and wet gas. Dry gas contains no combustible material except methane or a mixture of methane and ethane, hydrocarbons which cannot be condensed to liquid form except under conditions of extremely high pressure and low temperature. It contains no natural gasoline and is, therefore, used directly as a source of heat, light, or in the manufacture of carbon black. It is seldom found in oil fields, but is common in gas fields and in near-by districts unassociated with oil. Wet gas, the gas obtained from oil fields, contains appreciable quantities of condensible hydrocarbons which are extracted in what is called natural gasoline, this being a very broad term for the various hydrocarbons extracted. Between the two is a gas which contains minute quantities of such hydrocarbons but not enough to make their extraction economically feasible. This is called lean gas. It is used directly just as is dry gas, and is quite prevalent in the Appalachian fields.[1]

Gas wells are drilled in the same manner as oil wells, and if the well produces no oil, the gas may be piped directly from the well. Where gas is accompanied by oil special gas-tight casing heads with pipes for leading off the gas are used. It is this fact that has given wet gas the name of "casing-head" gas. Also, some gas is expelled directly in the stream of oil flowing from the well, and various types of separators or traps are in use for the recovery of this gas. Wet gas is then treated for the recovery of the natural gasoline before it is sent into the pipes for transportation to consumers.

Natural gas is produced in greater or less commercially important quantities in many parts of the United States, and many other districts are considered by geologists to be potential areas of natural-gas production. Commercially, however, the major

[1] Petroleum Industry of the Gulf Southwest, U. S. Department of Commerce, Domestic Commerce Series, *Bulletin* 44, pp. 214–215.

producing districts may be grouped into four principal areas: (1) the Appalachian fields, including most of the natural-gas-producing areas east of the Mississippi River; (2) the Mid-Continent fields, embracing the natural-gas-producing districts in the states of Missouri, Kansas, Arkansas, Oklahoma, Texas, Louisiana, and New Mexico; (3) the Rocky Mountain fields, including the areas in Montana, Wyoming, Utah, and Arizona; and (4) the Pacific Coast fields in California and Washington. Natural gas was first produced commercially in the Appalachian fields and up to 1920 the great bulk of the total production came from the fields in Pennsylvania and West Virginia, but since that time the trend of discovery and development has been westward, with the discovery of huge resources in the Mid-Continent and Pacific Coast areas.

The production of natural gas increased slowly during the latter half of the last century, but even so there was a tremendous wastage of this valuable resource, it being used extravagantly near the sources of supply. During the nineties production increased more rapidly as a result of the building of many pipe lines, and increases continued year by year until 1916. From 1916 to 1920 production remained nearly constant, and in 1921 it actually decreased more than 17 per cent from the previous year. This led to many predictions that the production of natural gas had reached its peak and would henceforth decline. However, since then new and larger deposits have been discovered and natural-gas production has almost trebled, production increasing from 662 billion cubic feet in 1921 to a peak of 1,943 billion cubic feet in 1930. During 1931 the steady expansion of the natural-gas industry was interrupted, production declining 13 per cent below that for 1930. This decline was the first in any year after 1921. The downward trend continued during 1932 and 1933, the marketed production during the latter year reaching a low of 1,555,474 million cubic feet. In 1934, however, marketed production registered a notable recovery, rising to 1,770,721 million cubic feet. The major portion of the recovery in 1934 was due to a material gain in the demand for industrial purposes.

The bulk of natural-gas production in the United States takes place in a relatively few states. Of the 1934 production, 1,460,-429 million cubic feet, or 82.4 per cent of the total, was produced

in five states—Texas, California, Oklahoma, Louisiana, and West Virginia, in the order of their importance. Other states producing considerable quantities, in the order of their importance, were Pennsylvania, Ohio, Kansas, Kentucky, New Mexico, and Wyoming. Together these six states produced 263,824 million cubic feet, or 14.9 per cent of the total, making a total of 1,724,253 million cubic feet for the eleven states named, or 97.3 per cent of the total production for the United States as a whole.[1] Figures for natural-gas production and consumption are shown in Table 4.

Natural-gasoline Production.—Natural gasoline was first produced on a small scale, in 1900, by a few oil producers in West Virginia and Pennsylvania, but by 1910 it was established as a commercial industry. The proportion of wet gas so treated has increased steadily until the total production is now treated for the recovery of natural gasoline. The earlier method of extraction by compression has largely been displaced by extraction through absorption. The latter method produces natural gasoline less dangerous to handle and richer in heat units per unit of volume. It is the only practical process for the recovery of natural gasoline from lean gas. Natural-gasoline production in the United States increased from about 7,000,000 gal. in 1911 to 2,234,000,000 in 1929. Since then there has been a decline, production in 1933 being 1,420,000,000 gal.

The bulk of the natural gasoline produced in the United States is used for blending with low-grade refinery naphtha to produce a commercial grade of gasoline. Such fuel is superior to straight-run gasoline, having a low initial boiling point that makes for easy starting of motors. The development of "cracking" technology, however, with the production of gasolines with equally good starting qualities, has tended to reduce this advantage. The growing apathy of refiners toward natural gasoline is due to the fact that volatility and antiknock, the chief qualities imparted through the use of natural gasoline, may usually be obtained at lower cost through proper operation of cracking equipment. In addition, most of the large refineries have installed vapor-recovery systems, whereby "absorption gasoline," a product similar to natural gasoline, is produced.

[1] Bureau of Mines, Natural Gas, statistical appendix to "Minerals Yearbook," 1935, p. 32.

TABLE 4.—SALIENT STATISTICS FOR NATURAL GAS IN THE UNITED STATES, 1912, 1922, AND 1930–1933

	1912	1922	1930	1931	1932	1933
Natural gas:						
Production, millions of cubic feet	562,203	762,546	1,943,421	1,686,436	1,555,990	1,555,474
Exports:						
To Canada, millions of cubic feet	....	.....	107	74	83	69
To Mexico, millions of cubic feet	....	.....	1,691	2,157	1,610	2,089
Imports from Canada, millions of cubic feet	......	.....	21	44	38	83
Consumption:						
Domestic, millions of cubic feet	193,455	254,413	295,700	294,406	298,520	283,197
Commercial, millions of cubic feet			80,707	86,491	87,367	85,577
Industrial:						
Field, millions of cubic feet	(*)	197,850	723,165	571,365	529,378	494,459
Carbon-black plants, millions of cubic feet	(*)	53,629	266,625	195,396	168,237	186,781
Petroleum refineries, millions of cubic feet	(*)	(*)	98,842	75,548	67,467	66,333
Electric public utility power plants† millions of cubic feet	(*)	27,172	120,290	138,343	107,239	102,601
Portland-cement plants,‡ millions of cubic feet	(*)	(*)	41,256	31,381	296,127	334,451
Other industrial, millions of cubic feet	368,748	229,482	315,059	291,319		
	562,203	762,546	1,941,644	1,684,249	1,554,335	1,553,399
Domestic, percentage	34	33	16	18	19	18
Commercial, percentage			4	5	6	6
Industrial, percentage	66	67	80	77	75	76
Number of consumers:						
Domestic, thousands	1,623	3,015	5,035	6,443§	6,506	6,629
Commercial, thousands			413	518§	531	537
Industrial, thousands	15	(‖)	21¶	28¶	30¶	30¶
Number of producing gas wells	30,905	(‖)	55,020	55,756	54,156	53,640
Value (at wells) of gas produced:						
Total, thousands of dollars	(‖)	84,873	147,048	117,505	98,985	97,096
Average per M.C.F., cents	(‖)	11.1	7.6	7.0	6.4	6.2
Value (at points of consumption) of gas consumed:						
Total, thousands of dollars	84,564	221,535	415,519	392,156	384,123	369,119
Domestic, thousands of dollars	50,961	126,902	200,615	208,262	223,377	209,699
Commercial, thousands of dollars			38,558	41,347	44,000	42,582
Industrial, thousands of dollars	33,603	94,633	176,346	142,547	116,746	115,838
Average per M.C.F.:						
Domestic, cents	(‖)	(‖)	67.8	70.7	74.8	74.0
Commercial, cents	(‖)	(‖)	47.8	47.8	50.4	49.8
Industrial, cents	9.1	18.6	11.3	10.9	10.0	9.8
Domestic and commercial, cents	26.3	49.9	63.5	65.5	69.3	68.4
Domestic, commercial, and industrial, cents	15.0	29.1	21.4	23.3	24.7	23.7
Treated for natural gasoline:						
Quantity, millions of cubic feet	4,688	545,139	2,088,778	1,790,119	1,499,756	1,551,464
Percentage of total consumption	0.8	71	108	106	96	100
Natural gasoline:						
Production, thousands of gallons	12,081	505,832	2,210,494	1,831,918	1,523,800	1,420,000
Value at plants:						
Total, thousands of dollars	1,157	72,711	128,160	63,732	49,244	54,368
Average per gallon, cents	9.6	14.4	5.8	3.5	3.2	3.8
Carbon black:						
Production, thousands of pounds	(‖)	67,795	379,942	280,907	242,700	269,325
Value at plants:						
Total, thousands of dollars	(‖)	5,820	14,852	8,621	6,664	7,449
Average per pound, cents	(‖)	8.6	3.9	3.1	2.7	2.8

* Included under "Other industrial"; separate figures not available.
† U. S. Geological Survey.
‡ Bagley, B. W., "Mineral Resources," chapters on Cement.
§ Revised figures.
‖ Figures not available.
¶ Exclusive of oil- and gas-field operators.
Source: Bureau of Mines, "Natural Gas."

Natural gasoline is also used extensively in airplane motors. The development of aviation has created a demand for fuel with specifications well met by natural gasoline. Other uses are found in the household, in the chemical industry, and a small amount for refrigerants. Some use is made of natural gasoline as a diluent for viscous crude oils to facilitate their transportation. Of the 1,420,000,000 gal. of natural gasoline produced in 1933: 1,010,478,000 gal., or 71.1 per cent, were blended at refineries; 54,054,000 gal., or 3.8 per cent, were run through pipe lines in California; 5,505,000 gal., or 0.4 per cent, were blended at natural-gasoline plants east of California for the production of motor fuel to be sold direct to consumers; 198,618,000 gal., or 13.9 per cent, were exported or sold to jobbers; and 4,796,000 gal., or 0.3 per cent, were added to stocks. The rest of the production was lost or unaccounted for.[1]

Production of Liquefied Petroleum Gases.—Attention should be called again to the production of liquefied petroleum gases, chiefly butane and propane, from natural gas and natural gasoline. In recent years this production has grown to large proportions. In 1931, the Bureau of the Census reported the production of these gases at refineries alone as 255,139,669 gal. Production at natural-gasoline plants is not known, although it is assumed to be somewhat less than at refineries. The major portion of the output of liquefied petroleum gases is used as fuel where produced, total sales in 1931 amounting to less than 10 per cent of the total production. Marketed production has shown consistent and rapid gains during the past 10 years, however, and the trend seems to be upward. Marketed production in 1933 amounted to 38,931,058 gal., as compared with 222,641 gal. in 1922. The distribution of propane was about 15,834,730 gal., the distribution of butane, 19,056,230 gal., and of the mixtures of these gases, 4,040,048 gal. Segregation of the 1933 marketed production according to the three principal types of use showed that 16,625,588 gal., 42.7 per cent, were marketed for domestic uses; 13,987,095 gal., 35.9 per cent, for industrial and miscellaneous uses; and 8,318,325 gal., 21.4 per cent, for gas manufacturing, either as a raw material for gas manufacture or as an enriching agent. Shipments of 14,415,563 gal. were

[1] Bureau of Mines, Natural Gasoline, statistical appendix to "Minerals Yearbook," 1934, p. 367.

made in cylinders or drums, and bulk shipments of 24,515,495 gal. by tank car or truck or by pipe line. Some portion of the bulk shipments was used by distributors in filling their own cylinders for local distribution.[1]

Future of Natural-gas Production.—In view of the fact that natural gas is an exhaustible, irreplaceable resource, it might be well to take stock of the reserves which at present seem to be available. A decade or more ago, as we have seen, the exhaustion of natural gas seemed imminent, but that was before some of the greatest sources of supply had been discovered. Although estimates of reserves are but rough approximations, the reserves of natural gas in the United States have been variously estimated to be in the neighborhood of 34 trillion cubic feet. This with a present annual consumption of less than 2 trillion cubic feet would last at least 17 to 20 years. The reader is cautioned against such estimates, since they are based upon knowledge which unfortunately must remain inadequate. Nevertheless, natural gas being an irreplaceable resource, whatever quantity the earth contains must eventually be used up, although the rate at which it is exhausted may be retarded by reducing the wastes in production, transportation, and consumption. However, since between 60 and 70 per cent of natural gas is produced in conjunction with oil the amount brought to the surface will depend not alone upon the demand for natural gas but also upon the demand for petroleum and its products. It is not beyond reason to visualize an increase in demand for petroleum products which would bring about a rapid exhaustion of both petroleum and natural-gas resources. On the other hand, joint production may act as a factor in the conservation of natural gas.

Interesting in this connection is speculation regarding the future of the long-distance transmission lines recently built. It may be said, in the first place, that the life of estimated reserves seems to be great enough to provide for the amortization of the investment in most of this pipe-line mileage if the prices obtained in the various markets are reasonably adequate. But assuming that the lines are well maintained and are in good condition when natural gas shall have become exhausted they may well be used for the transportation of gas manufactured at

[1] *Op. cit.*, p. 371.

low cost at the mouths of coal mines or near the sources of other fuels. A careful scrutiny of the map of the United States will show that practically all of the recently laid natural-gas pipe lines pass directly through or adjacent to the largest coal areas in the country.

Transportation of Natural Gas.—The transportation of natural gas is not a separate and distinct process but one inseparably connected with its production. Pipe lines must be laid to lead the gas from the well to the ultimate consumer. While it is still true, as we shall see, that a large part of the consumption of natural gas takes place near the wells, it is also true that it has been piped to consumers as far as a thousand miles away, and the development of long-distance transportation to large consuming markets has been the principal factor in the growth of the natural-gas industry within recent years.

There is some difference of opinion as to where the first natural-gas pipe line was laid, but as early as 1824 a line conducted gas from a well near Fredonia, New York, into the town where it was used for lighting. In 1828 and 1829 some parties received a contract from the United States government to supply the Barcelona harbor lighthouse on Lake Erie from a well near Westfield, New York, which they did for a number of years. In 1841 William Tompkins piped gas from a well in Kanawha Valley, West Virginia, to some salt vats to evaporate the water, and shortly before 1860 gas was being used to fire drilling boilers and to light and heat houses in Pennsylvania, West Virginia, and Ohio. In 1872, a 2-in. line was laid from the Newton well to Titusville, Pennsylvania, a distance of five miles.

Until 1891, natural-gas lines were short and usually small in diameter, generally not exceeding 8 in. Rock pressure does not remain constant in natural-gas wells and is not sufficient for economical transportation over great distances. To make such transportation economical, it was necessary to devise a system with compression plants to force the gas through the pipes, which in turn necessitated the development of pipe lines and joints capable of withstanding high pressures. Wooden pipes were first used, but the wastage was very great and transportation was limited to short distances. The first cast-iron natural-gas line was the line into Titusville, Pennsylvania,

laid in 1872, and this was followed later by wrought-iron and steel pipe with screwed couplings. In 1891 the Indiana Natural Gas and Oil Company laid two parallel 8-in. pipe lines from natural-gas wells near Greentown, Indiana, to Chicago, a distance of 120 miles. These lines were of wrought iron, connected by screwed couplings, and the gas was forced through the pipes by mechanical compression at an initial pressure of 525 lb. This enterprise marked the beginning of long-distance, high-pressure transmission in the United States.[1]

The early lines produced the network of interlocking, intercommunicating systems which has been to the present time the basis for the distribution of natural gas in sections near the sources of supply. A new era in natural-gas production and transportation has been ushered in since 1926, however, with the realization of huge supplies of natural gas in the Mid-Continent and the Pacific Coast fields, and improvements in the manufacture and laying of pipe. This new era may be said to have been introduced by the laying, in 1926, of a 22-in. line from the Monroe gas fields in Louisiana to Baton Rouge, a distance of 170 miles, followed by a 90-mile, 18-in. extension to New Orleans. From that day to this there has been a tremendous amount of construction of long-distance lines 20, 22, 24, and 26 in. in diameter, reaching out over distances of 1,000 miles or more, during which time such important cities as San Francisco, Los Angeles, Salt Lake City, Denver, Sioux City, Des Moines, Lincoln, Chicago, Indianapolis, St. Louis, Memphis, New Orleans, Birmingham, Atlanta, and Washington have been connected to natural-gas fields.

Among the factors responsible for the growth of long-distance transportation of natural gas are: (1) the discovery of huge supplies and the assurance of ample reserves, together with the increasing demands for natural gas; (2) lowered pipe-line costs, due to improvements in pipe manufacture and the development of machines and processes for laying, such as ditching and back-filling machines, tractors and derricks for moving pipe into place, automatic field welding, etc.; and (3) the activity of large companies formerly interested only in the production and transportation of crude petroleum.

[1] HENDEE, R. W., "Transportation of Natural Gas from the Field to the Market," pp. 4–5, A. G. A., New York.

According to the Bureau of Mines there were in the United States on July 1, 1931, about 50,000 miles of natural-gas trunk lines. No figures are available for natural-gas gathering lines, but it is assumed that the total is probably less than for trunk lines. Gathering lines are used to gather gas from groups of wells and to bring it to the trunk lines. In 1932 and 1933 there was a marked decline in natural-gas pipe-line construction, but this can be readily explained by the fact that most of the larger fields were already connected to large consuming markets by pipe lines.

Interstate movements of natural gas increased steadily, as a result of the development of long-distance transmission, until 1930, but declined approximately 13 per cent in 1931. There was a slight further decline in such shipments in 1932, but the total rose in 1933 and again in 1934, the total for the latter year being 414,183 million cubic feet. This amounted to nearly one-fourth of the total output of the United States for that year. The increase in the interstate shipments in 1933 and 1934 was due more to increased shipments through the established systems, than to operations of new lines.

Natural-gas Costs.—We have noted the change in the natural-gas industry from purely local systems serving areas adjacent to the wells to huge ones which reach out to far-distant markets. The profitableness with which a given market may be served with natural gas is dependent largely upon costs, since the price which will be paid for the gas will in no small degree depend upon the price of competitive fuels. Costs per M.C.F. of producing natural gas tend to increase with increase in the volume of business and the passage of time. With increased demand and utilization, the supply from particular wells decreases and efforts must be made to find new supplies. New wells must be drilled, pipe lines must be extended to more distant fields, and additional compressing and pumping stations must be installed.

The costs of pipe-line construction and operation vary so much on different properties that average figures are misleading. Pipe lines, it must be realized, are laid under all sorts of conditions—over mountains, through swamps, in cold and warm climates, over and under rivers, in mud, sand, or solid rock. Construction costs vary with the pressure of the gas at the well;

the cost of the transmission line, including pipe and protective covering, and compressor stations; the cost of rights of way, ditching, welding, and all field operations; the cost of a telephone or telegraph line for dispatching; the useful life of the line; and many others. The principal element in cost is, of course, the transmission line. Factors which affect its cost are: the size and kind of piping used, the system of construction employed, the character of the terrain, the amount and cost of excavation or overhead construction, the amount of gas to be delivered, etc. The cost of pipe varies directly with the weight, which in turn varies directly with the diameter times the thickness. With increases in the diameter and the pressure, the thickness of the pipe must be increased. Because an increase in the diameter of pipe increases the capacity more rapidly than the corresponding increase in cost, however, the general tendency has been to use pipe of sufficiently large diameter to deliver the capacity required at pressures up to 350 to 400 lb. per square inch, although the economic aspects of gas transportation through smaller lines at pressures as high as 1,500 lb. are being considered.[1] Often lines are telescoped; that is, where a 16-in. line is required pipe may be laid in 14-, 16-, then 18-in. sections, the diameter increasing in the direction of the flow as the pressure decreases. The effect is to reduce the total weight of the pipe, and hence its cost, through the use of thinner pipe where pressures are lower.

Compressing stations vary in cost, as do the "booster" stations which must be placed at intervals along the route to maintain the pressure. These stations are usually composed of large gas-engine compressors in single units of 1,000 to 1,500 h.p., installed in batteries of five to fifteen engines. Thus, for example, on the line from Perryville, Louisiana, to St. Louis, 431 miles long, five compressor stations are installed, each with six 1,000-h.p. compressors. The extent to which the full capacity of a line is utilized obviously affects costs per unit, since the fixed charges per M.C.F. decrease with improvement in the load factor. The useful life of a pipe line varies among other factors, with the type of surface material in which it is laid. Pipe lines are usually covered with asphalt or similar material to prevent corrosion, and are buried fairly deep in some sections to protect them from temperature changes.

[1] *Report of the Federal Oil Conservation Board*, 1930, pp. 12–14.

Maintenance costs include not only the cost of repair work, but the wages of pipewalkers and others who patrol the lines daily to discover leaks, washouts, and other conditions detrimental to the operation of the line. Leakage is, of course, costly and every effort is made to reduce its volume, in the beginning by constructing gas-tight joints, later by an efficient system of inspection. The use of welded joints has brought about considerable saving of gas leakage.

Operating costs include the costs of pumping, compressing, and dispatching. The dispatching of natural gas through a pipe line is comparable in a way to that of an active railroad trunk line, except that gas moves in only one direction and there are many distinct problems. Pressures at various points must be watched carefully to ensure that the proper volume of gas is being delivered and at the right pressure. Dispatching is done mostly by telephone, which requires that a telephone system be installed and maintained.

Consumption. *Domestic and Commercial.*—Domestic and commercial consumption roughly amounts to only one-fifth of the total consumption of natural gas in the United States. It amounted to 23 per cent in 1931, but this was due not so much to increased domestic and commercial consumption as to the falling off in industrial consumption during that year, the increase in total domestic and commercial consumption being only 1.2 per cent over 1930. Total consumption by domestic consumers in 1931 actually declined 0.4 per cent below 1930, although commercial consumption increased 7.2 per cent. Domestic consumption was 296 billion cubic feet in 1930 and 294 billion cubic feet in 1931, these amounts being 16 and 17 per cent, respectively, of the total consumption for those years. Corresponding figures for commercial consumption were 81 and 87 billion cubic feet, or 4 and 7 per cent, respectively, of total consumption.

Except in 1919, the number of domestic and commercial consumers has increased steadily for nearly 30 years. This growth has resulted chiefly from the steady expansion of pipeline mileage whereby more and more communities have been served with natural gas, the largest annual increases occurring since 1927 with the development of large-diameter, long-distance transmission lines. Domestic and commercial consumers in

1933 totaled 7,166,000. Of these, 6,629,000 were domestic consumers, and 537,000 commercial consumers. These figures include domestic and commercial consumers of mixed gas. The consumption of natural gas mixed with manufactured gas has increased rapidly in recent years.

Average consumption per domestic and commercial consumer has declined from 127.9 M.C.F. in 1910 to 51.5 M.C.F. in 1933. This has been due to many factors which include the growth in the number of small consumers, lessened consumption by other consumers due to rises in the price of natural gas, the loss of house-heating load in certain sections, and others. In 1933 average consumption per domestic consumer was 42.7 M.C.F., and 159.3 M.C.F. per commercial consumer. These figures are affected by the amount of mixed gas used. If the number of consumers of mixed gas and the quantities of natural gas used by them are eliminated, the average consumption of straight natural gas in 1933 per domestic consumer was 52.5 M.C.F., and per commercial consumer 194.7 M.C.F.[1] The average amount of natural gas consumed per domestic consumer is thus more than twice the average amount per domestic consumer of manufactured gas.

Industrial.—About four-fifths of the natural gas consumed in the United States is by industrial users. The largest single item each year since natural-gas statistics have been compiled, amounting at times to 38 per cent of the total consumption in the United States, is the use for field operations—drilling and pumping oil and gas wells—and use in natural-gasoline plants. This use is directly related to the accessibility of natural gas.

The next important single item in industrial consumption is the use of natural gas in carbon-black manufacture. Carbon black is usually manufactured by burning natural gas with insufficient oxygen to permit complete combustion, and allowing the smoky flame to impinge against a surface to which the fine carbon particles produced adhere, and from which they are subsequently scraped. Prior to 1915 about the only use for carbon black was as a pigment in paint manufacture, ink, blacking, and polishes. In that year, however, the demand for zinc

[1] Bureau of Mines, Natural Gas, statistical appendix to "Minerals Yearbook," 1934, p. 124.

in the manufacture of munitions forced the price of zinc oxide to such a height that the rubber industry was forced to look for a substitute as a filler and used carbon black. This substitute has proved so much worth while that the rubber industry today is the principal user of carbon black. The next important use is for ink. Other uses include the manufacture of paint and enamel, stove and shoe blacking, phonograph records, black leather, opaque photographic papers, typewriter ribbons, carbon paper, carriage cloths, oilcloths, linoleum, and many others.

Consumption of natural gas in the generation of electricity has rapidly become one of the major items in consumption, amounting to 7 per cent of total consumption in 1931. The amount so used increased more than 160 per cent in the 11-year period ending with 1930. Such consumption, however, is restricted mostly to the areas of natural-gas production. In 1929, for example, 68.6 per cent of the natural gas used for fuel in electric generating plants in the United States was consumed in the Gulf Southwest and 23.9 per cent in California, leaving less than 8 per cent for plants in the rest of the country.

Consumption of natural gas at oil refineries, which in 1933 amounted to only 4 per cent of total consumption, formerly was a much more important item. Natural gas in this use has heavy competition with fuels produced on the spot with no transportation charges. Many refiners have found it cheaper to utilize fuels made at their plants (fuel oil, refinery gas, and coke) than to buy natural gas from outside companies. Fuel oil is the most important refinery fuel, but the decline in the use of natural gas in refineries has been largely due to the competition of refinery gas.

Other industrial uses of natural gas, as of manufactured gas, are for metalworking, glassworking, smelting, brick and pottery making, baking, etc. Together these uses amounted to 21.5 per cent of the total consumption in 1933. Natural gas has come into extended use industrially because of its cheapness, ease of handling, simplicity of equipment, and efficiency. Because of certain qualities, like manufactured gas, it has no direct competitor for some uses; but for others price is the principal competitive factor. Increase in industrial consumption of natural gas in recent years has been due to piping to old

industrial centers, and partly to the migration of manufacturing concerns to the immediate vicinity of oil and gas fields. Figures for domestic and commercial and industrial consumption of natural gas are shown in Table 4.

Natural gas competes with coal and fuel oil in most of the markets in the Middle West and in certain other sections of the United States. It has been estimated that in more than three-fourths of the area of the United States natural gas occupies a dominating position as a fuel. In six states it is the only type of gas used, and in five more it constitutes over 90 per cent of all gas consumed. Natural gas constitutes over 80 per cent of all gas used in California, and over 60 per cent of all gas produced in Pennsylvania.[1]

In older natural-gas regions not much additional domestic-cooking load can be expected; some may even be lost to electricity. There is some prospect of increased gas water heating, although there is now a fairly high degree of saturation. Much of the house-heating load developed when the price of natural gas was inordinately low has been lost to cheaper fuels, as have many of the larger houses, installations in small hotels, apartment houses, etc. Some additional domestic load may come from the newer uses of gas—refrigeration, incineration, clothes drying and ironing, etc.—but, on the whole, increased use will probably come from house heating, especially space heating. Little increase in commercial load can be expected since in these regions most hotels, restaurants, bakeries, etc., are already using natural gas for practically all purposes. Industrial consumption in the older sections has tended to fall off with increased price of natural gas, due to the competition of oil and coal, or oil and coal gas.

In sections where natural gas is being introduced for the first time considerable opportunity exists for the expansion of the domestic load. Gas service is usually cheaper than before and there is a tendency not only to use gas more freely, but to install appliances which formerly were considered too costly to operate with manufactured gas, especially water heaters. House heating in such sections presents almost a virgin field for natural gas. Similarly, the introduction of lower cost gas service results in

[1] Where Is Natural Gas Going? editorial, *A. G. A. Monthly*, May, 1930, p. 192.

increased sales for all kinds of commercial and industrial uses.[1] Table 5 presents recent trends in the consumption of natural gas in the United States.

Natural-gas Rates.—Rates for manufactured gas have been discussed adequately in Chap. II. Here we shall refer briefly to some special problems in the construction of rate schedules for natural gas. Historically, rates for natural gas have passed through a marked evolution. In the early days of the industry, rates for natural gas were flat, either so much per customer per month or year, or so much per appliance per month or year. Most of the early natural-gas fields were discovered in the search for petroleum and since there was but little market for the gas it was allowed to escape into the air, or it was sold for whatever small sum could be obtained for it. Customers using natural gas felt that it was a gift of nature and objections were raised when rates above a nominal amount were charged. Rates, therefore, were extremely low and wastage occurred on an enormous scale. Gradually, however, a market for natural gas was developed, but the wasteful use of gas made it necessary, as wells became depleted, to seek more distant supplies or new deposits with which to serve the already developed markets. Costs of doing business thus increased and the practice of metering became more general.

Meter rates for natural gas are closely similar in type to those for manufactured gas. Our discussion of natural-gas rates can therefore be brief. When thermal content, *i.e.*, heating value, is considered, natural-gas rates are usually lower than manufactured-gas rates. There are, however, wide variations in natural-gas rates, accounted for by (1) the varying distance which the gas must be piped to consuming markets, (2) the differences in composition of gas from different fields, and (3) the fact that it has been difficult to increase markedly the very low rates originally offered in the early fields.

The nature of the production costs encountered in natural gas differs somewhat from those of manufactured gas. There are no raw materials to be processed in manufacture and, except for wells and collecting lines, there is no manufacturing plant to contribute fixed charges. The primary investment for a

[1] GARDNER, B. H., Selling Natural Gas, A. G. A., *Natural Gas Proceedings*, 1931, pp. 19–25.

TABLE 5.—TRENDS IN NATURAL-GAS CONSUMPTION IN THE UNITED STATES, 1925–1934
Percentage of total consumption

Class of service	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
Domestic and commercial...	22.90	22.03	20.48	20.47	18.77	19.41	22.63	24.84	23.74	21.50
Industrial:										
Carbon-black manufacture	11.81	9 93	9 97	11 17	13.62	13 75	11 64	10.81	12.02	13.03
Fuel for field operations...	35.64	36 42	38 02	36 59	36.77	37.23	33.91	34.04	31.83	31.42
Electric-power-plant fuel.	3.91	4 05	4 35	4 93	5.88	6.18	8 19	6.88	6.61	7.30
Fuel at refineries.........	7 39	9 25	8 54	7 33	5 41	5 10	4 51	4.37	4.27	4.53
Other industrial..........	18 35	18.32	18 64	19.51	19.55	18.33	19 12	19.06	21.53	22.22
Total industrial........	77.10	77.97	79.52	79.53	81.23	80.59	77.37	75.16	76.26	78 50
Total...............	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Compiled from Bureau of Mines data.

natural-gas company, therefore, is in the pipe line transmitting the gas to the consuming center. Once at the consuming point, the costs for distribution mains, etc., are essentially the same as those in manufactured gas. Many manufactured-gas companies have shifted completely or partially to natural gas. Such companies either mine their own gas or purchase it from mining or transporting companies. In either event, it is pumped into the company's holders, formerly used for manufactured gas, and from there supplied to the distribution system. Rates for natural gas so supplied are governed essentially by the same principles as those governing manufactured gas.

Except for those companies which have shifted from manufactured to natural gas, few natural-gas companies use holders for storage. Their storage is accomplished either through use of abandoned wells or through the "packing of transmission lines." Depleted and nearly depleted oil sands are natural reservoirs of large capacity. In sealed reservoirs, practically all the gas stored can be recovered and frequently this gas has become impregnated with gasoline from the unrecoverable oil which in turn can be recovered. Storage of this nature is particularly valuable for new producing properties which frequently furnish a great deal more gas than is required by the available market. Since the initial flow from such properties is usually of short duration and the well thereafter settles down to a smaller production more in line with probable demands, storage in abandoned wells is a desirable way of preventing the loss of their initial larger flow.[1] Storage to care for the peak-load requirements on the pipe line is usually accomplished by packing the line. In modern, high-pressure lines, natural gas is subjected to a pressure of several hundred pounds per square inch. By varying this pressure from day to day or from hour to hour, the different requirements on the pipe line can be supplied. The line must, to offer storage, be constructed to withstand pressure of gas needed to meet the maximum consumption during any 24-hour period of the year and any 1-hour period of the day.[2]

[1] Petroleum Industry of the Gulf Southwest, U. S. Department of Commerce, Domestic Commerce Series, *Bulletin* 44, 1931, pp. 144 *ff*.

[2] Jones, Eliot, and T. C. Bigham, "Principles of Public Utilities," pp. 347 *ff*., The Macmillan Company, New York, 1931.

Since the wells, pipe-line, and distribution system of a natural-gas utility must be large enough to handle peak-load demands, it follows that rates for natural gas should consider carefully customers' demands and off-peak usage. In this respect, except for the actual amount of the rates, the rate schedules for natural gas should be similar to those for manufactured gas. Natural-gas rate schedules must give particular consideration to the problem of the peak load. Due to the fact that most natural-gas companies have a large heating load, which load varies with climatic conditions and has a sharp seasonal peak in the winter months, the annual load factor for the natural-gas pipe line is usually very low. This offers a real problem in connection with the operation of long pipe lines. There is need for developing an industrial and commercial load to balance the heating load. Such a load, if it can be developed for the off-peak season, can be served at relatively low rates, and to be developed, such an industrial and commercial load must be offered low rates, since the natural gas would be in competition here with cheap fuel.[1] Increased development of off-peak rate schedules for natural gas can therefore be expected.

SUMMARY OF GAS DEVELOPMENT IN THE UNITED STATES

On Jan. 1, 1931, there were 477 companies distributing manufactured gas, 646 distributing natural gas, 33 distributing both manufactured and natural gas, and 39 distributing liquefied petroleum gas, making a total for the country of 1,195 companies. Of these, 936 companies distributed gas only, while 259 distributed gas and electricity. There were 16,009,684 gas customers or 130 customers per 1,000 total population. Of these, 10,471,218, or 65.4 per cent, were manufactured-gas customers; 5,524,066, or 34.5 per cent, were natural-gas customers; and 14,400, or 0.1 per cent, were liquefied-petroleum-gas customers.

The highest development was found in the Middle Atlantic States (New Jersey, New York, and Pennsylvania) with 203 customers per 1,000 total population. Then followed the Pacific Coast section with 190, New England with 179, and the East North Central section (Illinois, Indiana, Michigan, Ohio, and Wisconsin) with 161 customers per 1,000 total population.

[1] Petroleum Industry of the Gulf Southwest, U. S. Department of Commerce, Domestic Commerce Series, *Bulletin* 44, 1931, pp. 145 *ff.*

The lowest development appeared in the East South Central section (Alabama, Kentucky, Mississippi, and Tennessee) with only 33 customers per 1,000 total population. Next lowest was the Mountain section (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming) with 54, and next to that the South Atlantic section (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia) with 58 gas customers per 1,000 total population.

There is a significant difference between the number of gas customers per 1,000 population in counties supplied with gas, and the number per 1,000 population in communities supplied with gas. As is to be expected the former, reflecting rural development, is much lower than the latter, the development for the entire country being 155 for the former, and 217 for the latter. The Pacific Coast section, with 254, leads all others in gas customers per 1,000 population in communities supplied with gas. Then follow the Middle Atlantic section with 233, East North Central with 229, New England with 217, and West North Central (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota) with 203 gas customers per 1,000 population in communities supplied with gas. It is significant also that the sections lowest in total development are also lowest in development in communities supplied with gas, although this development is relatively much higher than the development in counties supplied with gas, figures for the East South Central section being 60 for the latter development, and 127 for the former. Corresponding figures for the Mountain section were 89 and 151, respectively; and for the South Atlantic section, 93 and 165, respectively.

There were 7,832 communities in the United States supplied with gas, 3,074 with manufactured gas, 4,650 with natural gas, and 118 with liquefied petroleum gas. Ten communities were supplied with both manufactured and natural gas. Communities supplied with manufactured gas were concentrated mostly in the following sections: Middle Atlantic with 1,180; East North Central with 957; New England with 363; and South Atlantic with 224. The section having most communities supplied with natural gas was the West South Central, including the states of Arkansas, Louisiana, Oklahoma, and Texas. In

this section only one community, Helena, Arkansas, was supplied with manufactured gas. Next was the Middle Atlantic section with 982 communities, and then the East North Central with 748, the West North Central with 598, and the South Atlantic with 526. Only two communities in the United States of more than 15,000 population were without gas service; and of 8,676 communities in the United States with populations of over 2,000, only 844, or 9.7 per cent, were without gas service.[1]

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CHAPTER IV

THE ELECTRIC LIGHT AND POWER INDUSTRY

The Origin and Development of Electric Light and Power.—Electricity was first commercially applied within the last 100 years and its development for light and power has come within the last 50 years. Within this time, electricity has revolutionized artificial lighting and, owing to convenience, efficiency, and reliability, it is playing an increasingly important role as a source of industrial power. It is recognized as one of the most important features of our present-day industrial and economic life.

Increasing knowledge of this mysterious force was developed during the nineteenth century. Volta, in 1800, succeeded in getting continuous current from an electric battery made of disks of silver, zinc, and cloth saturated with salt water to form the voltaic pile. The arc light, while not commercially developed until the end of the century, was discovered by Davy in 1802 and was publicly demonstrated in 1809. Davy also experimented with incandescent lamps, using platinum as a filament. Magnetic rotation, the basis of the electric motor, was discovered in 1821 by Faraday. In the same year, he also developed the principle of the dynamo by producing an electric current from a conducting wire moved in the vicinity of a magnet. Pixii constructed the first dynamo in 1832. Primary cells, as a source of electric energy, were introduced by Daniell in 1836 and Grove in 1837.[1]

Commercial application of these and other discoveries was soon made. Needle telegraph systems, embodying the principles of electromagnetism, were tried in Russia, in 1832, by Schilling. The dot-and-dash system of Morse, developed in 1844, finally

[1] The data for the historical development of electric light and power are based upon Electric Power Industry, vol. II, Chap. II, Federal Trade Commission, Senate Document 46, 70th Cong., 1st Sess. For a more detailed discussion, see T. C. Martin and S. W. Coles, "The Story of Electricity," New York, 1919.

prevailed. The telephone, invented in 1876, was the next important commercial application of electricity. As in the case of the telegraph, the telephone has no special connection with the generation and distribution of electricity so that these services and the electric light and power industry have developed along independent lines.

The basis for the development of central generating stations was given by the arc light which was the first commercial application of electricity requiring the generation of electric current in considerable quantities. After Davy demonstrated his arc light, various others were tried so that by 1840, and the decades immediately following, arc lights were in limited use in public halls, theaters, and some open spaces. The operation of these early arc-light installations was from voltaic-cell batteries which was a method too expensive for general commercial application. The electric dynamo was not capable of supplying the current for arc lights until after certain improvements were made in 1863 and in 1870. Soon thereafter, many arc-lighting systems developed. The first system installed was in Philadelphia, in 1877, with a single lamp for each circuit. Lamps in series, each with individual control, followed shortly. The direct-current dynamos used in the earlier system installations were replaced by alternating-current apparatus. Arc-lighting dynamos have practically disappeared with the development of central stations with alternating-current generators supplying current for all needs.

The incandescent light provided the impetus for the rapid development of the electric light and power industry. This started in 1882 with the opening of the now famous Pearl Street station in New York City by Thomas A. Edison. While known early in the nineteenth century, incandescent lights were not practical because the platinum filaments then used melted when heated to the extent necessary to give more than a few candle power of light. Edison overcame this difficulty and introduced a much perfected lamp in 1879. Since this date, the incandescent lamp has been further improved and the present tungsten-filament lamps give over 10 times as much light as their predecessors.

Artificial lighting required large quantities of current at low cost, thereby giving demand for dynamos since their discovery

in 1831 had demonstrated them to be an efficient way of transforming mechanical power into electrical energy. Utilization of the same construction principle permits the transformation of the electric energy into mechanical power by the revolutions produced in the electric motor. Thus, the electric power industry developed concurrently with the lighting industry. The first commercial dynamos were of the direct-current type with a low voltage. Distribution of the current was limited to a few thousand feet adjacent to the generating station. Alternating-current generators followed the invention of the transformer and the sphere of operation for the distribution of energy was materially enlarged. The use of alternating current, however, retarded the development of power applications since motors were then driven by direct current. This limitation was overcome, in 1888, by Tesla who invented a polyphase alternating-current motor. Also, the rotary converter was invented and it became possible to transform alternating into direct current for those uses where direct current is necessary or more desirable. The use of alternating current made possible larger generators, improved the reliability of the service, and promoted safety. The enormous development and extension of the electric light and power industry are based directly upon this contribution.

Generator units presented the next obstacle to the development of the industry. Generator capacities of 3,000 to 5,000 horsepower had been constructed by 1903, but they seemed to have reached the limit in size for practical use, driven, as they were, by low-speed steam engines. These generators were heavy and expensive to build and occupied a large amount of space. New generator units were required for enlargements and extensions in service and this created a demand for station space in the urban areas where the value of real estate was high. As rapid increase in the demand for electricity took place, the central stations experienced greater difficulty in supplying sufficient generator capacity. More generator capacity in each unit, driven by higher speed engines, was an apparent need. The invention of the steam turbine solved this problem and the use of turbo-generators marks the beginning of modern, low-cost electric generation. Capacities of generator units have shown a constant increase from the 5,000-horsepower units of the early years of the century to 12,000 horsepower by 1909, 20,000

horsepower by 1913, 30,000 horsepower by 1916, and 75,000 horsepower by 1933. One unit of over 200,000 horsepower has been constructed. Increased efficiency has paralleled the increase in generator capacity with a constantly decreasing fuel consumption per kilowatt-hour of energy produced.

Hydroelectric plants have developed concurrently with steam plants. The first hydroelectric plant was built in Appleton, Wisconsin, in 1882, and started operation in October of that year. The first water-wheel generator was installed in 1884, in Oregon, the current being transmitted for a distance of 13 miles from the Willamette River to Portland. The technological inventions in the industry have been usually as adaptable to hydro generation as to steam generation. Particularly is this true of the inventions and improvements which have made possible the long-distance transmission of energy, this development being one of the major contributions to the development of hydroelectric plants.[1]

Growth of the Electric Light and Power Industry.—The development of the electric light and power industry has been rapid. Numerous inventions and technological advances, following closely upon one another, have permitted an extension of electrical services to new uses and to new users. Electric light and power now stands as one of the major industries of the country and its services are widespread, for both domestic and industrial purposes. The extent and the rate of this development are indicated in statistical data published annually by the *Electrical World* and the Edison Electric Institute (formerly the National Electric Light Association). Comprehensive statistics of the industry are published also at five-year intervals, beginning in 1902, in the "Census of Electrical Industries" by the United States Bureau of the Census but unfortunately the data from these three sources are not always comparable.

The statistical evidence of the rapid growth of the industry is presented in Table 6. The statistical data for 1902–1932 inclusive are adopted from the "Census of Electrical Industries" while those for 1933–1935 are taken from data published by the *Electrical World* and thus are not absolutely comparable. It is believed, however, that sufficient similarity exists to give an

[1] GLAESER, MARTIN G., "Outlines of Public Utility Economics," p. 65, The Macmillan Company, New York, 1927.

accurate picture of the rapid development of the industry. The magnitude of these figures is impressive but they become more so when it is realized that the development and the growth of the industry have taken place almost entirely since 1900 and that since 1902 the number of customers increased more than 43 times, the rated generator capacity of plants increased more than 27 times, the current generated increased more than 37 times, fixed capital increased more than 25 times, and gross operating revenues increased more than 28 times.

The generation and distribution of electrical energy for the years 1926 to 1935 are shown in Table 7 and the revenues derived therefrom are shown in Table 8. The trend in distribution to all customers was rapidly upward from 1926 to 1929 inclusive, then registered declines for 1930 to 1932 with an upward trend again starting in 1933. The trend in current distributed to domestic consumers, which was upward during the entire period except for 1933, is indicative of the stability which this service contributes to the industry. Kilowatt-hours distributed to retail light and power customers declined in 1931, 1932, and 1933, and the number distributed to wholesale power and light customers declined in 1930, 1931, and 1932, but started to increase again in 1933 though it has not yet reached the peak attained in 1929. Revenues derived from the sale of current have followed, in general, the trend noted for the distribution of current to customers. Total revenues declined in 1931, 1932, and 1933, this being accounted for primarily by the declines in revenues from wholesale light and power which began in 1930 and continued through 1933. Domestic revenues showed declines in both 1932 and 1933 but the subsequent increases have carried them to a level higher than that attained in the preceding peak in 1931. In 1935, domestic consumers, though making use of approximately 18 per cent of the current distributed to ultimate customers, provided over 36 per cent of the total revenues received from the sale of electric energy.

Some observers believe that the peak in the rate of growth of the electric light and power industry has been passed and that a more stable and less rapid rate of growth for the future can be expected. In this connection, it is stated that a large part of the growth in the last two decades has been in the electrification of former steam-powered industrial plants and that the

TABLE 6.—SELECTED STATISTICS OF THE ELECTRIC LIGHT AND POWER INDUSTRY, 1902–1935

Item	1902	1912	1922	1932	1933	1934	1935*
Number of establishments	3,620	5,221	6,355	3,429	†	†	†
Number privately owned	2,805	3,659	3,774	1,627	†	†	†
Number municipally owned	815	1,562	2,581	1,802	†	†	†
Fixed capital‡ (millions of dollars)	504.7	2,175.7	4,465.0	12,664.4	12,800.0	12,900.0	13,100.0
Revenues: electric service§ (millions of dollars)	85.7	302.3	1,072.1	2,157.3	1,906.1	1,980.4	2,068.5
Total expenses (millions of dollars)	68.1	234 6	859 6	1,566.4	†	†	†
Number of employees	30,326	47,632	150,762	244,573	232,000	247,000	248,000
Capacity of generators: Rated (millions of kilowatts)	1.212	5.165	14.313	34.622	33.970	33.932	33.900
Output: Kilowatt-hours generated (billions of kilowatt-hours)	2.507	5.862	40.291	79.657	79 983	85.970	93.575
Number of customers‖	582,689¶	1,946,979	12,709,868	23,861,642	24,295,515	24,808,537	25,341,203

* Estimated, generally on the basis of 10 months' operation.
† Not available.
‡ Reported as "Plant and equipment" by the Census.
§ Reported as "Income" by the Census and includes nonoperating revenues.
‖ Includes ultimate customers and those purchasing energy for resale.
¶ Meters on consumption circuits.
Source: Data for 1902–1932, "Census of Electrical Industries," data for 1933–1935, *Electrical World*, vol. 106, No. 1, p. 70, 1936.

TABLE 7.—DISTRIBUTION OF CENTRAL-STATION ENERGY, 1926–1935
Millions of kilowatt-hours

Year	Generated in central stations	Distributed to ultimate consumers								Losses	Company use		Total including purchased energy
		Total	Domestic	Commercial light and power		Municipal street lighting	Electric railways	Electrified railroads	Municipal and miscellaneous		Railway	Other	
				Retail	Wholesale								
1926	69,158	56,089	6,827	9,485	32,615	1,589	4,951	426	196	11,834	1,530	1,023	70,476
1927	74,686	61,251	7,676	10,766	35,263	1,741	5,039	504	262	12,659	1,348	1,111	76,369
1928	82,927	66,988	8,619	11,692	38,903	1,911	4,991	560	312	13,842	1,330	1,235	83,395
1929	91,421	75,294	9,773	13,106	44,326	2,038	5,049	590	412	14,983	1,279	1,201	92,757
1930	89,952	74,906	11,018	13,944	41,621	2,227	4,997	591	508	14,561	1,184	1,306	91,957
1931	86,312	71,902	11,738	13,544	38,451	2,320	4,549	626	664	14,162	970	1,366	88,400
1932	77,868	63,764	11,987	12,932	31,186	2,364	4,175	540	580	13,678	843	1,220	79,505
1933	79,983	65,754	11,960	12,475	33,723	2,213	4,004	661	718	14,256	699	1,204	81,913
1934	85,970	70,782	12,798	13,151	36,919	2,203	4,352	703	656	14,782	652	1,361	87,577
1935*	93,575	77,355	13,993	14,053	41,184	2,329	4,379	825	592	16,039	600	1,380	95,374

* Estimated on 10 months' operation.

Source: *Electrical World*, vol. 106, No. 1, 1936, p. 57.

TABLE 8.—REVENUE OF THE ELECTRIC LIGHT AND POWER INDUSTRY BY SOURCES
In thousands of dollars, 1926–1935

Year	Revenue from ultimate consumers								Other electric service*	Total revenue for electric service*
	Total	Domestic	Commercial light and power		Municipal street lighting	Electric railways	Electrified railroads	Municipal and miscellaneous		
			Retail	Wholesale						
1926	1,520,159	478,182	427,407	488,915	68,023	47,618	4,373	5,641	101,391	1,621,550
1927	1,661,032	523,689	482,136	519,074	77,248	47,965	5,172	5,748	141,623	1,802,655
1928	1,784,309	571,620	519,957	549,989	83,024	46,489	5,560	7,670	157,646	1,941,955
1929	1,938,520	618,799	555,640	613,172	88,323	46,277	5,986	10,323	167,380	2,105,900
1930	1,990,955	664,441	575,598	590,992	95,458	46,068	6,015	12,383	160,195	2,151,150
1931	1,975,944	678,611	564,524	570,127	99,299	41,912	6,725	14,746	149,166	2,125,110
1932	1,832,596	669,200	528,861	476,450	100,919	38,311	5,821	13,034	147,394	1,979,990
1933	1,773,416	656,570	499,684	465,191	94,270	36,359	6,550	14,792	132,694	1,906,110
1934	1,837,046	677,697	511,682	495,657	92,984	37,838	6,726	14,461	143,414	1,980,460
1935†	1,923,500	709,200	536,600	532,500	89,200	36,900	7,300	11,800	145,000	2,068,500

* Including sales for resale, involving some duplication.
† Estimated on the basis of 10 months' operation.
Source: *Electrical World*, vol. 106, No. 1, 1936, p. 58.

substitution of electricity for steam cannot continue indefinitely. The fact that practically the whole of the more densely populated areas of the United States are now provided with electricity would also indicate a lessened rate of growth for the future as new lines will of necessity be in less densely populated areas. It is further stated that decreasing rates for electric energy have acted as an incentive to rapid growth and while further rate reductions are possible, continued marked reductions in rates cannot be made.[1]

Major Trends in Development. 1. *Use by and Cost to Domestic Customers.*—The trend in the sales of current to domestic customers and the revenues derived from domestic services indicate that this class of business is important to the industry because of its size and its relative stability. The number of domestic customers has tended to increase each year except during 1931 and 1932 and is now substantially more than the previous peak of 1930. The number of customers, by classes, from 1928 to 1935 inclusive is shown in Table 9. Of even more significance than the number of customers in influencing stability of revenues from this class of service is the fact that the average annual use of current has increased steadily, having more than

TABLE 9.—NUMBER OF CUSTOMERS, BY CLASSES, 1928–1935

Year	Total	Domestic	Small light and power	Large light and power and other
1928	23,153,252	19,089,882	3,532,489	530,881
1929	24,147,183	19,967,154	3,598,115	581,914
1930	24,555,732	20,331,551	3,628,653	595,528
1931	24,489,770	20,151,247	3,724,013	614,510
1932	24,149,300	19,849,963	3,687,636	611,701
1933	24,295,515	20,004,098	3,697,324	594,093
1934	24,808,537	20,484,232	3,727,478	596,827
1935*	25,341,203	20,987,563	3,772,007	581,633

* Estimated generally on 10 months' operation.
Source: Adapted from *Electrical World*, vol. 106, No. 1, p. 70, 1936.

doubled since 1913. In that year, average annual consumption by domestic customers was 264 kw.-hr. and in 1932 it was 611 kw.-hr. The average cost or charge per kilowatt-hour has

[1] Editorial, *Electrical World*, vol. 98, Nov. 7, 1931, p. 815.

shown a steady decrease during this period of time. The average revenue per kilowatt-hour for domestic service was 8.7 cents in 1913 and in 1932 it was 5.5 cents, a decline of over 36 per cent. More service at lower rates has thus been accomplished. Economies in electric generation and distribution have contributed to this trend but the customer has been active in putting himself in a more favored position by making a more general use of lighting services and by adding and using more electrical appliances. The small-load appliances such as toasters, irons, and vacuum sweepers have been followed by the larger load appliances such as refrigerators, ranges, and water heaters.[1]

The industry is recognizing that the use of appliances offers the possibility of further increase in the average domestic consumption. The number of domestic customers cannot be increased indefinitely so that sales and promotional activities have been directed toward increasing the use of domestic appliances and much success has been achieved. Most of the average increase in domestic consumption noted above has taken place since 1926, fully three-fourths of the increase being attributable to refrigerators, ranges, and water heaters. These three appliances now account for one-third of the total domestic consumption and, with other appliances, account for almost one-half of the present domestic consumption. The possibility of further increases by stimulating the use of heavy-duty appliances is indicated when it is realized that only 1 out of every 9 domestic customers has a refrigerator, 1 out of 20 a range, and 1 out of 80 a water heater.[2] Expanding use of electric refrigerators was the most prominent factor in maintaining domestic energy sales in 1933.

The trend in the increasing consumption of current by domestic appliances is graphically presented in Fig. 3.

2. *Appliance Sales.*—Emphasis upon appliance use by domestic customers resulted in many utilities directly selling appliances. This activity, particularly in the field of electric utilities, has created much discussion in recent years. The utilities claim that their merchandising activities are beneficial not alone to

[1] National Electric Light Association, *Statistical Bulletin* 8, July, 1932, pp. 3 and 4; "Census of Electrical Industries," 1932, p. 22.

[2] *Electrical World*, The Promise of the Domestic Load, vol. 99, Jan. 2, 1932, p. 69.

themselves but also to the customers of the company; the company profiting by the revenues received from the electric energy used by the appliance and the purchaser of the appliance being assured of good quality merchandise. Furthermore, the increased sales of energy make possible the realization of economies of large-scale production and reduce unit costs of output, thus permitting lower rates to customers generally.

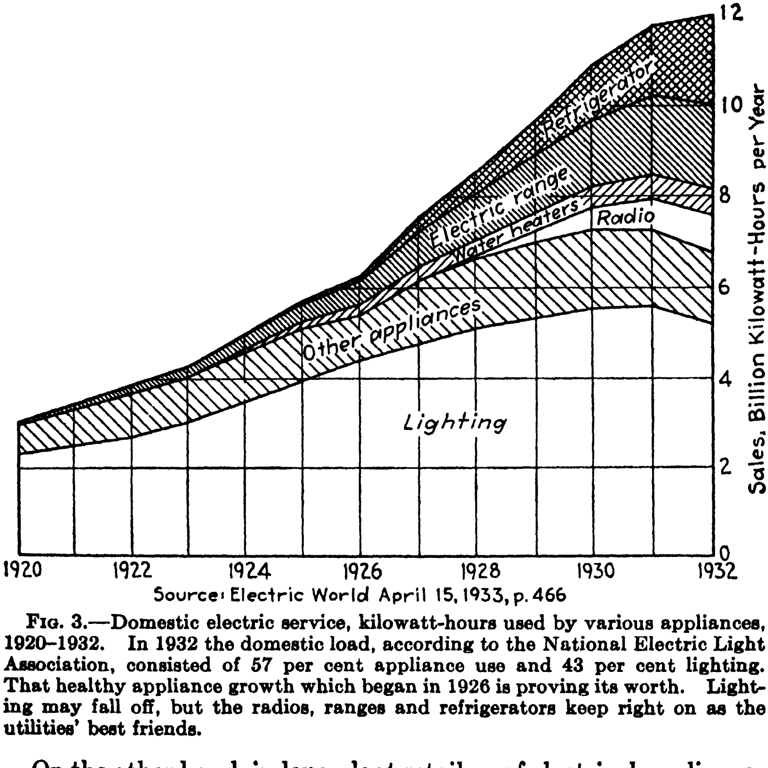

FIG. 3.—Domestic electric service, kilowatt-hours used by various appliances, 1920–1932. In 1932 the domestic load, according to the National Electric Light Association, consisted of 57 per cent appliance use and 43 per cent lighting. That healthy appliance growth which began in 1926 is proving its worth. Lighting may fall off, but the radios, ranges and refrigerators keep right on as the utilities' best friends.

On the other hand, independent retailers of electrical appliances claim that competition from utilities should not be permitted. This competition is claimed to be unfair in many cases because utilities offer price concessions or other inducements, covering their losses on merchandise sales from utility revenues. Such opposition has resulted in several states in the passing of so-called "utility anti-merchandising" laws, and in other states the regulatory commissions have ruled that merchandising activities and accounts must be kept entirely segregated from the com-

pany's public utility activities and accounts. In some cases the utilities have attempted, frequently with success, to develop a program of cooperation and coordination of appliance sales activities with independent dealers in the area served by the utility.

An extensive use of appliances is absolutely necessary to a program of low rates for domestic service. Comparatively low rates for this service cannot be extended unless the average consumption of domestic customers is materially increased and the use of appliances is the most effective way to produce this result. The utilities have recognized this fact and intensive appliance merchandising has usually accompanied the adoption of promotional rate schedules. Emphasis has been placed upon appliances as load-sustaining or load-building devices even though promotional rates to stimulate directly their use were not offered. Rentals of appliances, especially water heaters, ranges, and refrigerators, have been offered by some companies. The trend of the increasing consumption of current by appliances has been earlier noted. It is not generally realized, however, that appliance sales since 1929 have been large and particularly in 1934 and 1935 were there large sales of appliances.[1] The National Power Survey reports that the capacity of appliances sold from 1930 through 1934 amounts to almost 29 million kilowatts and estimates that their annual consumption of current will be over eight billion kilowatt-hours.[2]

3. *The Electrification of Industry.*—The increase in the use of electric power by industry has been even more rapid in recent years than has been the increase for domestic uses. Wholesale power and light in 1935 utilized over 53 per cent of the total current distributed to customers and provided almost 28 per cent of the industry's revenues. The rapid electrification of industry is shown in Table 10 which presents data concerning the proportion of industrial power supplied by purchased electrical energy. By 1929, more than 44 per cent of the installed horsepower capacity in industries was in motors to be driven

[1] The *Electrical World*, vol. 105, No. 7, p. 66, 1935, contains data on sales from 1916 to 1934 and Vol. 105, No. 18, p. 27, 1935, gives sales figures for a limited number of companies for the first half of 1935.

[2] Federal Power Commission, National Power Survey—*Interim Report, Power Series* 1, pp. 13 and 15.

by purchased current and in that year, as reported in the "Census of Manufactures," industries paid $475,633,877 for purchased electric power, this amount being 22.6 per cent of the total cost of fuel and power used by industries.

TABLE 10.—INSTALLED INDUSTRIAL MOTORS TO USE PURCHASED ELECTRIC POWER

Year	Total horsepower of electric motors operated on purchased power	Electric motors on purchased power is percentage of total horsepower
1899	182,562	1.8
1904	441,589	3.3
1909	1,749,031	9.4
1914	3,884,724	17.4
1919	9,284,499	31.7
1923	13,365,663	40.4
1925	15,868,828	44.3
1927	19,132,310	44.5
1929	22,775,664	44.5

Source: Adapted from U. S. "Census of Manufactures," 1929, Table 1, Prime Movers, Motors, etc., p. 112.

Availability, flexibility, and cost have been largely responsible for the increased use of electric power in industry. Central stations, on the whole, have been alert to the possibilities of industrial power sales. In fact, the very nature of the industry has dictated that this business be developed. If it supplies a domestic lighting and appliance load only, a company finds that it has a heavy load at night, particularly in the early evening, with a very much smaller load during the day. Idle equipment in the generating plant thus results and this is expensive. Accordingly, attempts have been made to increase the use of electrical energy during those off-peak periods when the station capacity is but partially used. This involved the development of industrial loads, since industrial-power uses offered the only large daytime demand. Promotional efforts have been directed to this end and specially devised rate structures have been offered. Rate differentiation, as a means of building the load and thereby promoting economies in operating costs and the distribution of fixed costs over a larger output, has come to be generally practiced and is usually sanctioned by the

regulatory commissions. The tendency toward larger plants also has contributed to the need for developing the industrial load.

4. *Rural Electrification.*—Almost 800,000, or approximately one-eighth, of the farms of the United States are electrified. Practically all the development of rural electrification by central stations has taken place since 1920. Once undertaken, growth was very rapid until 1929 when there occurred a material decrease in the number of farms added. There was a small increase in the number added in 1930 which was followed by large decreases through 1933, but in 1934 and 1935 there was again an increase in the number of farms added. In addition to these farms which are served by central stations, it is estimated that there are approximately 250,000 farms served by individual lighting plants. Table 11 presents the number of farms served by central stations, the percentage of all farms thus served, and the increase in the number of farms served each year for the period of 1923 to 1935.

TABLE 11.—FARMS SERVED BY CENTRAL STATIONS

Year	Number of farms served	Percentage of total farms served	Increase in number of farms served
1923	177,561	2.8	
1924	204,780	3.2	27,219
1925	246,150	3 9	41,370
1926	309,125	4.9	62,975
1927	393,221	6 2	84,096
1928	506,242	8.0	113,021
1929	576,168	9.2	69,926
1930	649,919	10.4	73,751
1931	698,786	11.1	48,867
1932	709,449	11.3	10,663
1933	713,558	11.4	4,109
1934	743,954	11.8	30,396
1935	793,977	12 6	50,023

Source: *Electrical World*, vol. 106, No. 1, p. 62, 1936.

The "Census of Electrical Industries" for 1932 reports 613,753 farm customers in the United States, this number being 2.6 per cent of all customers. Farm customers consumed 1,504,-

257,106 kw.-hr. of current, an average of 2,451 kw.-hr. per customer. Revenues for this service amounted to $42,773,826, or 2.3 per cent of all revenues from current sales. The farm customers paid an average of $70 per year for current at an average rate of 2.8 cents per kilowatt-hour. The *Electrical World* estimates that there were over 300,000 miles of rural electric lines by the end of 1935.[1] The rural areas of the United States offer a huge potential market for electric energy. The agricultural industry is one of the largest users of power and farm dwellings, barns, and other buildings offer an appreciable lighting load. Many obstacles, however, are being encountered in developing the rural service. Rural distribution lines are expensive relative to the possible load on each line. If costs are to be covered, rates for rural service must therefore be comparatively high and this acts as a deterrent to the development of the maximum use by each customer. Many of the power needs of agriculture can be supplied economically and satisfactorily by electric motors but other forms of power, particularly for field operations, are still necessary and to have both requires a dual, or larger, investment in equipment which many farmers hesitate to make. It has also been true that often the rural users have been required to finance in whole or in part the distribution lines serving them. Such a capital investment has made it impossible for many of the users along the line to make also expensive investments in wiring, household appliances, and farm machinery. This situation results in limited use with a small load which, in turn, necessitates high rates.

The electric light and power industry has recognized the existence of these obstacles and is making an effort to overcome them. Construction costs on rural distribution lines have been materially reduced as a result of experimentation with various kinds of materials and types of construction;[2] more liberal policies in financing the rural distribution lines have been instituted; marked achievements in building a heavier load have been accompanied by lower rates; and rural agents have been placed in the field to advise and assist in solving the prob-

[1] *Electrical World*, vol. 106, No. 1, p. 77, 1936.

[2] The laying of an underground cable in a plowed furrow seems to offer a cheap and satisfactory rural distribution line for some types of topography.

lems which arise in making use of electric power. Machinery and equipment manufacturers have contributed to the development of rural service by designing equipment to meet the peculiar needs of these users. Present rural services are confined to the more densely populated areas adjacent to the towns and cities and dairy and poultry farms. Other applications include water pumping, irrigation (very important in certain western states), and small machinery units.

Renewed emphasis upon an expansion of rural electrification has resulted from the activities of the Tennessee Valley Authority and the Rural Electrification Administration. The social and economic rehabilitation of the Tennessee River valley area, as undertaken by the Tennessee Valley Authority, includes plans for rural electrification accompanied by a study of the resources of the area, experiments and demonstrations in agriculture, experimental areas to demonstrate the possibility of the use of electric power in both farms and city homes, and cooperation in developing industries in which part-time employment can be supplemented by farming.[1] Looking toward increased rural use, the Tennessee Valley Authority has specified in its rate contracts that rural rates can be no higher than those offered in the towns, except that higher minimum monthly bills are permitted. Also, the Electric Home and Farm Authority, the appliance-merchandising agency of the Tennessee Valley Authority, places a great deal of emphasis upon sales of appliances to rural users and has undertaken educational programs to promote the use of appliances in rural areas.

The Rural Electrification Administration, created by Executive Order dated May 11, 1935, was established to initiate, formulate, administer, and supervise a program of approved projects with respect to the generation, transmission, and distribution of electric energy in rural areas. According to the Rural Electrification Administrator, it is planned "to promote increased use of electricity in rural areas by every legitimate means of education and demonstration. Intelligent promotion, backed by low rates and a liberal customer-financing plan for house wiring and equipment, can raise the average rural con-

[1] Glaeser, Martin G., The Federal Government's Tennessee Valley Power Project—No. 2: The Immediate and Ultimate Program, *Public Utilities Fortnightly*, vol. XIII, No. 7, p. 394, 1934.

sumption over 50 per cent."[1] By mid-November, 1935, little more than six months after being established, the Rural Electrification Administration had approved eleven projects involving an allotted expenditure of $2,339,612 for the construction of 2,040.3 miles of line to serve 8,286 farms.[2] It was proposed in bills presented to Congress on Jan. 6, 1936, to extend the life of the Rural Electrification Administration and to make available to it the sum of $100,000,000 annually for a 10-year period to be used in making loans for rural electrification.[3]

The Rural Electrification Administration, in order to fulfill its objectives, must rely heavily upon privately owned electric utilities since they supply more than 90 per cent of the users of electric current. Though the industry has expressed a willingness to cooperate with the Rural Electrification Administration in what it terms worth-while projects, there also have been criticisms and other opinions to the effect that individual company plans or cooperative plans, such as those of the Pennsylvania Joint Rural Electrification Committee and the Virginia Joint Committee on Rural Electrification, will offer a sounder and firmer development of rural electrification.[4]

5. *Fuels Used in Electrical Generation.*—One of the most marked technological achievements of the electric industry has been an improvement in the operating efficiency of steam generating plants. This improvement, measured in pounds of coal per kilowatt-hour of current generated, shows an improved efficiency of over 100 per cent between 1919 and 1935. In

[1] Church, Leonard, New Deal Proposed in Rural Electrification—an Interview with Morris Llewellyn Cooke, *Electrical World*, vol. 105, No. 14, p. 29, 1935. *Rural Electrification*, published by the Rural Electrification Administration, gives a monthly summary of rural-electrification activities.

[2] *Electrical World*, vol. 105, No. 24, p. 44, 1935.

[3] The bills became law, *Public No.* 605, on May 21, 1936, and appropriated $410,000,000 for the 10-year period.

[4] Reed, Hudson W., Rural Electrification, *Electrical World*, vol. 105, No. 12, p. 58, 1935; Everett, George, Farmer or Utility Ownership of Electric Lines, *Public Utilities Fortnightly*, vol. XVI, No. 13, p. 795, 1935; White, E. A., The Steady Demand for Rural Electrification—No. 1: Increasing Number of Farms Served, *ibid.*, vol. XVI, No. 5, p. 265, 1935; Saville, Allen J., The Steady Demand for Rural Electrification—No. 2: The Virginia Plan, *ibid.*, vol. XVI, No. 6, p. 312, 1935; McComb, William, The Steady Demand for Rural Electrification—No. 3: Making it Pay, *ibid.*, vol. XVI, No. 7, p. 428, 1935; Rural Service to Expand 50 per Cent, *Electrical World*, vol. 106, No. 1, p. 76, 1936.

the former year, 3.2 lb. of coal were necessary to produce 1 kw.-hr. of energy and in the latter year only 1.47 lb. of coal were required. Fuel consumption for the period 1919 to 1935 is shown in Table 12. No reduction in the quantity of fuel required per kilowatt-hour of current generated has been noted since 1933. In recent years, oil and gas fuels have become more prominent

TABLE 12.—FUEL CONSUMPTION, ALL PUBLIC UTILITY PLANTS, 1919–1935

Year	Coal (millions of tons)	Oil (millions of barrels)	Gas (billions of cubic feet)	Coal plus coal equivalent of oil and gas*	Pounds of coal per kw.-hr.
1919	35.10	11 05	21.41	38.88	3.2
1920	37.12	13 12	24.70	41 42	3.0
1921	31.59	12 05	23.72	35 24	2.7
1922	34 18	13 20	27 17	38 00	2.5
1923	38.97	14 68	31 43	43 52	2.4
1924	37.56	16.63	48 44	43.13	2.2
1925	40.22	10.25	46 52	44 78	2.1
1926	41.31	9.40	53 21	45 86	1.95
1927	41.89	6 78	62.92	45 91	1 84
1928	41 35	7.16	77 33	46.39	1 76
1929	44.94	10 12	112 71	52.57	1.69
1930	42.90	9.26	120 29	50.65	1.62
1931	38 73	8.12	139.33	47 13	1.55
1932	30 29	7.97	107.88	36.60	1.50
1933	30.58	9.94	102 60	37.16	1.47
1934	33.56	10.38	127.90	41.79	1.47
1935†	34 74	10 85	123.85	42.92	1.47

* Conversion ratio: 3.85 bbl. of oil and 23,100 cu. ft. of gas equal 1 ton of coal.
† Estimated on basis of 10 months' operation.
Source: *Electrical World*, vol. 106, No. 1, p. 67, 1936.

than they were a few years ago. In 1935, on the basis of U. S. Geological Survey equivalent ratios, oil constituted 6.8 per cent, gas 12.6 per cent, and coal 80.6 per cent of the fuel used by steam plants.[1] Not only is the improvement in generating efficiency significant as a reduction in operating costs of electrical generation, but it is also significant because of its parallel effect on the coal industry. The annual savings in coal consumption has the short-run effect of requiring proportionately less coal

[1] *Electrical World*, vol. 106, No. 1, p. 67, 1936.

from an overdeveloped industry and the long-run effect of conserving this natural resource.

6. *Growth of Large Central Stations.*—The early nature and conditions of the electric light and power industry, with emphasis upon incandescent lighting, fostered the development of small plants to supply needs in each local area. Competing plants, sometimes advocated in the belief that competition would insure low rates, were numerous. The technological progress in the electrical art and the inventions in the field, however, were along lines which made possible the development of larger and larger generating stations serving distribution areas of increased size. Competition between local plants ensued and the most efficient or the financially strongest companies survived and absorbed their weaker competitors. As the industry developed, with single companies gaining control over the production and distribution of electric energy in specific areas, the increasing size of the producing units resulted in economies giving decreasing costs per unit of output.[1] The initial cost of the generating equipment per kilowatt of capacity decreases with increases in the size of the generating unit. Operating expenses per unit of output, assuming the same degree of utilization of capacity, also are less in larger than in smaller plants. It has also been found that a large plant with many customers can supply their demands for current with a plant capacity which is smaller in relation to the combined maximum demands of the customers than is the case of smaller plants with fewer customers.[2] It is obvious that if all customers made their maximum use of the service at the same moment, then the capacity of the plant would have to equal their combined total demands. It is also obvious that the possibility of such simultaneous use becomes less as the number of customers increases. This relationship is technically known as the diversity factor, which has already been defined.[3] Since the diversity factor is likely to be greater in the larger plants, the large-size plant finds a saving in its investment in plant and equipment needed to supply the maximum momentary demand placed upon it,

[1] Federal Trade Commission, *op. cit.*, pp. 164–165.

[2] Jones, Eliot, and T. C. Bigham, "Principles of Public Utilities," p. 74, The Macmillan Company, New York, 1931.

[3] Chap. II, p. 30.

whereas the capacity of the smaller plant usually must be more nearly equal to the combined demands of its customers.

The load factor also favors the large plant, and the higher the load factor, the greater has been the use made of the equipment. This means that the fixed costs are spread over a larger output with a consequent lower cost per unit of output. It does not necessarily follow that a given large plant will have a higher load factor than a given small plant, but it does follow that a given large plant can serve the same customers with a higher load factor than that which could be obtained by two (or more) small plants serving the same customers.

Thus, technological advances have permitted, and economies of operation have dictated, the growth of large-size central plants. This development in generating facilities has been accompanied by developments in transmitting and distributing facilities to permit the marketing of the current. It should be noted that, as these larger generating and distributing systems have been built, there has been an increasing competition between systems to acquire control over a given territory. Interconnections, mergers, and consolidations find their genesis in this situation.[1]

The present size of electric power systems varies from plants serving only a few customers, a dozen or less, to systems serving over 2,000,000 customers. Likewise, individual plants vary from a few kilowatts to 770,000 kilowatts in capacity and from a few thousand kilowatt-hours to more than a billion kilowatt-hours of output annually. Data on the distribution of generating plants by size are not available but the extent to which the tendency toward large-size plants has manifested itself is indicated by data showing the capacity and output of the major power systems in the United States. The 215 systems reporting for the National Power Survey of the Federal Power Commission, in 1934, show a total installed capacity of 31,600,000 kilowatts and a production, for 1933, of 76.9 billion kilowatt-hours. This is 91 per cent of the capacity and 93 per cent of the output for the United States. There were 391 privately owned and 21 municipally owned operating plants represented in the 215 systems and each system had an annual output of 25 million kilowatt-hours or greater. Twenty-two of the systems each

[1] Federal Trade Commission, *op. cit.*, p. 165.

produced over one billion kilowatt-hours of current in 1933. The largest generating output by a single system, over five billion kilowatt-hours for 1933, was produced by the Niagara Hudson Power Corporation of New York.[1]

7. *Transmission Lines and Interconnections.*—During the early years of the electric light and power industry, it was possible to transmit the direct current generated for only short distances but, as alternating current displaced direct current, transmission over longer distances was made possible. The need for transmission of current in this early period was primarily for the transportation of energy from hydroelectric sites to market areas. In 1900, transmission for a distance as far as 25 miles was unusual and most of the generating plants of that time served an area which seldom exceeded 1 square mile in extent. The larger cities were served by several independent generating stations and small towns having electric service had their own plants. As improvements in the ability to transmit power over long distances were made, the separate generating and distributing systems in the larger cities gradually combined their operations and areas formerly supplied by separate generating plants began to receive their supply from substations which, in turn, were supplied by transmission lines from larger central stations. This growth continued and also extended to include transmission networks serving many communities from one or several central generating stations. The genesis of regional power systems is found in this situation.[2]

The present feasible distance for the transmission of current from the point of production to the point of consumption is approximately 300 miles, though there are cases where transmission distances are greater without a material increase in the percentage of energy lost during transmission, which usually amounts to about 15 per cent. Within the physical limitation for the distance for transmitting electrical current, the economic consideration of costs is significant. The necessity of high voltage and the loss of energy during transmission make long-distance movements expensive. Cost of transmission must be

[1] Federal Power Commission, *op. cit.*, p. 9. The *Electrical World* also publishes data covering the energy output of major systems; see, for example, vol. 99, pp. 818–821, May 7, 1932.

[2] Federal Power Commission, *op. cit.*, pp. 5 *ff.*

weighed against the cost of production at the point of consumption. The growth in the size of steam generating units and the development of large hydroelectric plants have tended to favor transmission rather than local generation. Thus, there is a tendency for both the voltage and lengths of transmission lines to increase. There were 251,408 miles of circuit of transmission lines in 1932, of which 151,869 miles were 33,000 volts or more and of these, 1,903 miles were 220,000 volts.[1]

The National Power Survey undertaken by the Federal Power Commission published a map of the transmission lines in the United States of 60,000 volts or more, except for lower voltage shown as part of interconnected systems. Examination of this map discloses that the highest development of transmission networks has taken place in the industrial districts east of the Mississippi River and along the Pacific Coast. Some of the outstanding transmission lines shown are:

a. The 285,000-volt line from Boulder Canyon to Los Angeles, now under construction.

b. The 220,000-volt line of the Pacific Gas and Electric Company from the Pit River in northern California to San Francisco Bay and Fresno.

c. The 220,000-volt network connecting Philadelphia, northern New Jersey, the Pennsylvania anthracite fields, Conowingo Dam on the Susquehanna River in Maryland, and the Wollenpaupauk development in the Delaware River basin in New Jersey.

d. The 220,000-volt line of the New England Power Company from the Fifteen Miles Fall on Connecticut River to Boston.[2]

Probably more significant than mileage and number of transmission lines is the fact that the development of transmission systems, bringing one into the area served by another, has led to the interconnection of systems. Such interconnection of generating plants through transmission systems has resulted in extensive networks, some of which supply as much as 100,000 square miles of territory.[3] In its simplest form, interconnection

[1] "Census of Electrical Industries," Central Electric Light and Power Stations, 1932, p. 25.

[2] Federal Power Commission, *op. cit.*, pp. 6 *ff.*

[3] Jones, Eliot, and T. C. Bigham, "Principles of Public Utilities, p. 40, The Macmillan Company, New York, 1931.

is the joining together of power systems in order to provide for the interchange of power with the aim of mutual protection of service and greater economy of operation. The interconnection may be all steam plants, all hydroelectric plants, or both. Usually, an interconnection brings together steam and hydro plants and this type of interconnection of generating stations into a transmission system may give what is known as a superpower system. It is not necessary that the interconnected generating stations be under common ownership or control, though, as will be noted later, there is some tendency for this to take place.

The advantages or economies resulting from interconnections are claimed to be the following:

a. Increase in general service reliability through the interchange of power at times of emergency and breakdown.

b. Increase in operating efficiency with the more efficient plants being operated regularly at full capacity and the less efficient plants being operated as a reserve for peak requirements.

c. Increased diversity permits operation with less equipment in reserve and thereby gives a saving in investment and fixed costs.

d. Improved load factors, not only because less reserve equipment is necessary but also because the peak on one system frequently offsets the peak on the other.

e. Staggered construction of excess equipment in anticipation of increased output offers savings in investment in plant and equipment. The systems which are experiencing an increase in their output find that such increase comes gradually over a period of time. The extra equipment needed to care for this growth cannot be installed gradually in small units but must be installed in a single or several large units in advance of the increase. This obviously means that the company must make an investment in plant and equipment which will not be wholly needed for some time. But if two (or more) interconnected systems will cooperate, one company can install excess equipment which will care for the increase on both its own system and that of the other company. As the growth of the two systems requires full utilization of the excess equipment installed by the first company, then the other company can provide the additional equipment needed to meet the growth on the two

systems for another period of time. Such savings constitute one of the chief advantages of interconnections.

f. More complete utilization of water power where hydro plants are interconnected and the low-water period on one watershed is offset by the high-water period on another.

g. Operating savings result when combined hydro and steam plants can be shifted from base- to peak-load operation in such a way that the steam plants can be operated at full load or shut down and thereby eliminate the stand-by losses occurring when steam boilers are kept fired in readiness to be put into production.[1]

There are no data available concerning the extent and number of interconnections. The existence of many high-voltage transmission lines indicates, however, that interconnections are very extensive. Much publicity has been given to the physical possibility of an interconnection from Maine through Boston to New York and thence to Chicago. Other similar possibilities are from Chicago to New Orleans and from New England down the Atlantic seaboard to Florida and Alabama. Even though such interconnections exist and have actually been operated for momentary periods of time, the publicity concerning them has given the false impression that they are general and that transmission of energy over such distances commonly occurs. The development of an interconnected network is limited by the economic area served, and within this area by distance and by the cost of transmission. Normally it is a relatively small area. The average distance for the flow of energy is only about 22 miles and while some 17 per cent of the total energy produced flows over state boundaries, such interstate movement occurs within these small, economic-area, interconnected systems and is not a flow from one state across another to a third. Where many plants are interconnected, there may be a relatively long distance between them but the flow of energy is from plant to plant and not from one terminus of the transmission line to the other. To illustrate, plant *A* has surplus energy and plant *D* needs additional energy. Intervening

[1] Voskuil, Walter H., "The Economics of Water Power Development," McGraw-Hill Book Company, Inc., New York, 1928, p. 22; and Funk, N. E., "Economies of Combined Hydro and Steam Power Systems," Second World Power Conference, vol. XI, pp. 281 *ff*.

plants B and C are operating at capacity and have neither surplus nor deficiency of energy. The transfer in this case would be made by A sending to B which uses energy from A and sends its own energy to C which, in turn, uses B's energy and sends its own energy to D. It is only through such a mechanism as this that the surplus of one plant can be made available to other plants which are connected to the same transmission line.[1] Failure to understand the real nature of interconnections has given rise to many mistaken ideas. The exaggerated belief that electricity can be transmitted great distances with economic justification contains only an element of truth. It is erroneous to assume that an interconnection exists simply because several companies' lines parallel or cross each other. These need not be joined as a single, magnified network and frequently are not so joined.

The advantages and economies of interconnection have in many cases been sufficient to offset the higher costs of transmission and have resulted in networks being formed. Several illustrations are cited. The Conowingo-Pennsylvania-New Jersey tie is an interconnection through a 220,000-volt line of the Philadelphia Electric Company, with a hydroelectric plant at Conowingo and steam plants in Philadelphia; the Public Service Electric and Gas Company of New Jersey, with a hydro plant at Wollenpaupauk and steam plants at Newark; and the Pennsylvania Power and Light Company, with steam plants in the coal regions at Sunbury. The primary purposes of this interconnection seem to be for reserve, diversity, and staggered construction. In view of the latter, large blocks of power will be interchanged as the excess capacity on one system is used to meet the growth and reserve demands on the other.[2] In the Southeast, a transmission system gives interconnection between plants operating in Alabama, Georgia, Tennessee, South Carolina, and North Carolina. This network is one of the most extensive in the United States and is made possible only through the control of operating companies by holding-company organiza-

[1] LIVERSIDGE, H. P., Facts and Fancies in Interconnection, National Electric Light Association, *Proceedings*, 1927, pp. 27 *ff*.

[2] BAILY, R., Fundamental Plan of Power Supply in the Philadelphia Area, *Journal American Institute of Electrical Engineers*, vol. 49, pp. 281–284, April, 1930.

tions with an operating committee composed of representatives from the holding companies to handle the interchange problems and to coordinate operation and development. The interconnection has been of value in making use of hydroelectric power from different watersheds and utilization of low-cost steam plants. The low-water period in the Carolinas comes at the high-water time in Alabama and Tennessee and, due to nearness of coal fields, there are many low-cost steam plants in Alabama.[1]

The coordinated development of operating plants in interconnected transmission systems has met with success and raised the question of the feasibility of a coordinated development of the power supply in larger regional economic areas. Some form of centralized control would be necessary and the lack of this is, at present, a deterrent to such development. The northeastern section of the United States, including the New England and Middle Atlantic states, offers possibilities of coordinated development. The coal areas of western Pennsylvania, Ohio, and West Virginia could support steam plants. Other steam plants could be located at cities along the Great Lakes, on the Chesapeake and Delaware bays, along the Hudson River, and on the Massachusetts bays. These steam plants, which would be in the sections of densest population in this area, could be coordinated with water-power developments along the Niagara, St. Lawrence, Delaware, Susquehanna, upper Ohio tributaries, Potomac, and the Maine rivers.[2]

8. *Holding Companies.*—It should be noted that development of large-sized hydroelectric and steam plants and their interconnection by means of transmission lines are one aspect of a larger situation; namely, that while transmission lines have permitted interconnection of generating units, it is also true that common ownership or control of the generating stations has tended to foster the development of transmission lines for interconnection purposes. The usual medium for effecting common ownership or control has been the holding company, and the development of this device as a phase of the electric light and power industry is now described.

[1] Morrow, L. W. W., Interconnected South, *Electrical World*, vol. 91, pp. 1077–1084, May 26, 1928.

[2] Northeastern Super Power Committee, "Super Power Studies for the Northeast Section of the United States," 1924.

In the early days of the development of the industry, electric light and power companies experienced many difficulties in securing funds for financing the rapid growth which was taking place. The local nature of the industry made it impossible for the companies to borrow on favorable terms in the financial markets so that equipment manufacturers found it necessary to render financial assistance by accepting securities in part or in full payment for equipment sold. In order to dispose of these security holdings and to be in a position to render more financial assistance to local operating companies, equipment manufacturers organized security companies. The Thompson-Houston Company, absorbed by the Edison interests in 1892, formed a securities company in 1890. Other manufacturers of equipment followed suit.[1] The need for capital, however, was greater than could be provided by this method, and other financing methods or devices found a fertile field. Gas holding companies served as models for these later financing developments. Holding companies, to own, build, and operate public utility plants and to own and deal in public utility securities, were incorporated.

Another important factor which contributed to the growth of holding companies in the electric light and power field is the fact that the construction and operation of a central station is a highly technical business. Local and small companies seldom had trained men available for this work so that consulting and construction engineering firms developed. As in the case of equipment manufacturers, these agencies had to accept securities in payment for their services. It was necessary in this case also that security affiliates be organized. Some of the larger companies developing along these lines are the Byllesby, the Barstow, the White, and the Stone and Webster interests.[2]

The economic foundation and theory of the holding company is that a large central organization can furnish more efficient and economical management, better and cheaper financing services, and sounder construction and operating policies than could be supplied by many of the independent companies. Some of the holding-company groups emphasize operation, some engineering services, some management, some financing,

[1] Federal Trade Commission, *op. cit.*, p. 166.
[2] *Ibid.*, pp. 172–173.

and some of them combine all of these activities. Further discussion of this matter may be found in Chap. XV.

9. *The Extent and Status of Municipal Ownership.*—No survey of the major trends in the development of the electric light and power industry would be complete without reference to the predominance of private ownership and operation in the industry. And, in common with the conditions found in most of the public utility industries, municipal ownership has never predominated in the electric light and power industry. Numerically, municipally owned establishments have comprised a substantial proportion of the total and, in 1927 and 1932, as reported by the "Census of Electrical Industries," more than 50 per cent of the electrical establishments were municipally owned. It should be noted, however, that the term "establishment" is defined for census purposes to signify a plant or plants under a single ownership. Since it is characteristic for municipally owned plants to operate in restricted areas and for some privately owned establishments to operate over wider areas, it is believed that the number of generating units in privately owned establishments is much larger than in municipal establishments. This conclusion is substantiated by an analysis of capital investments, revenues, kilowatt capacity of generators, and kilowatt-hours generated whereby it is seen that municipally owned establishments, in 1932, ranged between 4.2 per cent and 6.1 per cent of the total.

This analysis indicates also that the municipal establishments are generally comparatively small. Further, the facts that the municipal plants served more than 9 per cent of the customers and received over 6 per cent of the revenues indicate that these establishments served primarily domestic or residential lighting customers and that their rates for this service were comparatively lower. The "Census of Electrical Industries" substantiates this conclusion when it reports an average revenue per kilowatt-hour for all service as 2.7 cents and 3.1 cents for privately and municipally owned establishments respectively, and an average revenue of 5.6 cents per kilowatt-hour for the domestic service of privately as compared to 4.7 cents for municipally owned establishments.[1] Selected statistics, except for the comparative average revenues, which were used in this analysis are shown

[1] "Census of Electrical Industries," 1932, Tables 40 and 41.

in Table 13. It should be noted that no attempt is made here to evaluate the greater desirability of either type of ownership but that it is merely pointed out that privately owned establishments predominate in this field of public utility business.

TABLE 13.—EXTENT AND STATUS OF PRIVATE AND MUNICIPAL OWNERSHIP IN ELECTRIC LIGHT AND POWER UTILITIES

Item	Year	Total	Privately owned	Municipally owned	Percentage municipally owned
Number of establishments	1932	3,429	1,627	1,802	52.55
	1927	4,335	2,137	2,198	50 70
	1922	6,355	3,774	2,581	40 61
Fixed capital	1932	$12,664,376,952	$12,124,807,425	$ 539,569,527	4 26
	1927	9,297,458,356	8,880,291,499	417,166,857	4.49
	1922	4,465,015,691	4,229,356,023	235,659,668	5.28
Kilowatt capacity of generators	1932	34,622,554	32,647,578	1,974,976	5 70
	1927	25,811,305	24,383,271	1,428,034	5.53
	1922	14,313,438	13,407,041	906,397	6 33
Output: Kilowatt-hours generated	1932	79,657,466,651	75,692,668,065	3,964,798,586	4.98
	1927	74,686,378,010	71,306,839,538	3,379,538,472	4.53
	1922	40,291,536,435	38,413,240,163	1,878,296,272	4.66
Revenues: Electric service	1932	$ 1,975,303,955	$ 1,854,109,509	$ 121,194,446	6.14
	1927	1,802,655,493	1,680,218,664	122,436,829	6.79
	1922	1,020,439,038	936,851,679	83,587,359	8.19
Number of customers	1932	23,861,642	21,633,602	2,228,040	9 34
	1927	21,790,238	19,661,370	2,128,868	9.77
	1922	12,709,868	11,065,124	1,644,744	12.94

Source: Adapted from Table 6, "Census of Electrical Industries," 1932.

National Power Policy and Federal Power Projects.—The first tangible evidence of the emergence of a national power policy came in the bitter and protracted legislative struggle between the conservationists and the water-power interests which resulted in the creation, in 1920, of the Federal Power Commission. Investors in private water-power enterprises and advocates of state's rights in the South and West wanted rapid development of water power under private control while conservation interests, headed by the Forest Service, the Interior Department, and some Congressional committees advocated

public control over water-power developments on streams under Federal jurisdiction. Originally, as a compromise between these conflicting viewpoints, the Federal Power Commission was an ex-officio board composed of the Secretaries of Interior, War, and Agriculture. The duties of the board were to collect data on the utilization of water-power resources and to issue licenses to private or public projects to develop water power on navigable streams and waters on public lands. During its early years, the board reflected the viewpoints of its cabinet membership and its representation of the public interest was limited to a supervision of the development of power projects largely by private interests. A Congressional investigation in early 1930 disclosed that the Commission was ineffective in regulating power interests and in protecting the public interest so by Congressional enactment, approved June 23, 1930, there was established a reorganized Commission composed of five full-time commissioners. The new Commission immediately started studies and investigations of power problems and soon submitted positive recommendations to Congress covering such matters as the control over interstate transmission of power, the regulation of holding companies, and more effective control in determining investments made in licensed water-power developments.[1]

The political administration which was commenced with the inauguration of a new President of the United States on Mar. 4, 1933, has generally followed a more socially enlarged conception of national power problems than that entertained by preceding administrations. Mention has already been made of the programs designed to promote extensive rural electrification. In discussing the problems of Muscle Shoals, President Roosevelt emphasized the need for planning for power developments when he stated:

> It is clear that the Muscle Shoals development is but a small part of the potential public usefulness of the entire Tennessee River. Such use, if envisioned in its entirety, transcends mere power development; it enters the wide fields of flood control, soil erosion, afforestation, elimination from agricultural uses of marginal lands, and distribution of and diversification of industry. In short, this power development of war

[1] HERRING, E. PENDLETON, The Federal Power Commission and the Power of Politics, *Public Utilities Fortnightly*, vol. XV, No. 5, p. 223, 1935, and No. 6, p. 292, 1935.

days leads logically to national planning for a complete river watershed, involving many states and the future lives and welfare of millions. It touches and gives life to all forms of human concern.

Many hard lessons have taught us the human waste that results from lack of planning. Here and there a few wise cities and counties have looked ahead and planned. But our nation has just grown! It is time to extend planning to a wider field, in this instance comprehending in one great project many states directly concerned with the basin of one of our greatest rivers.

This is in a true sense a return to the spirit and vision of the pioneer. If we are successful here, we can march on, step by step, in a like development of other great natural territorial units within our borders.[1]

Looking toward a planned national power policy, President Roosevelt established on July 9, 1934, a National Power Policy Committee for the purpose of planning for the closer cooperation of the several factors involved in the electrical power supply of the United States, both public and private, in order that electricity might be made cheaper and more broadly available to all classes of customers. Acting in an advisory capacity, this committee is also to consider the lines to be followed in devising legislation aimed at the development of a national power policy.

Data to be available for use in such planning had previously been authorized to be collected by the Federal Power Commission by a National Power Survey and an Electric Rate Survey. *Interim Report, Power Series* 1, was issued in 1935 and analyzes the present and potential power requirements of the United States and the sources which can most economically and efficiently supply the future requirements. A survey of domestic and residential rates in cities of 50,000 population and over has been issued as *Rate Series* 1 for the Electric Rate Survey and other preliminary reports for smaller cities, amounts of rate charges, and typical bills are now being issued. The final reports are also to analyze promotional-rate policies, uniformity of rates, special contracts, and other electrical-rate data collected in the nationwide survey.

[1] Speech delivered by President Roosevelt at Warm Springs, Georgia, February, 1934, quoted by Martin G. Glaeser, The Federal Government's Tennessee Valley Power Project—No. 1, Its Genesis, *Public Utilities Fortnightly*, vol. XIII, No. 6, p. 319, 1934.

In addition to attempting to establish a national power policy, the Federal government has, by means of Public Works Administration grants and loans and various emergency relief expenditures, assisted in the construction of many power developments. And directly, the Federal government has allocated, by means of emergency funds or direct legislative appropriations, $403,860,000 for the construction of power projects. These are shown in Table 14.

Much public interest and attention have been given to the Tennessee Valley development. The Tennessee Valley Authority Act of 1933 authorized a development which will test the possibilities of extensive power developments for a large economic

TABLE 14.—FEDERAL GRANTS FOR CONSTRUCTION OF POWER FACILITIES

Project	Total estimated cost	Appropriated
Tennessee Valley Authority:		
Wilson Dam (now valued)	$ 20,000,000	
Norris Dam	36,000,000	
Joe Wheeler Dam	27,000,000	
Pickwick Dam	24,000,000	
Guntersville Dam	17,000,000	
Chickamauga	15,000,000	
Hiwasee Dam	12,000,000	
Plant and equipment	14,000,000	
Transmission and distribution	100,000,000	
Total T.V.A.	$265,000,000	$111,000,000
Central Valley, Colorado	170,000,000	15,000,000
Boulder Canyon	108,660,000	108,660,000
Fort Peck	86,000,000	71,000,000
Grand Coulee*	60,000,000	35,000,000
Bonneville	55,000,000	32,200,000
Passamaquoddy	36,000,000	10,000,000
Casper-Alcova	22,700,000	20,000,000
Bluestone Reservation (West Virginia)	12,942,000	1,000,000
Total	$816,302,000	$403,860,000

* Preliminary development only, ultimately in excess of $300,000,000.
Source: *Electrical World*, vol. 106, No. 1, p. 78, 1936.

area, with low-priced electricity being made available for widespread domestic, industrial, and rural uses. The plan for this development, in addition to the generation and distribution of electricity, includes the improvement of navigation on the Tennessee River, flood control, reforestation, fertilizer production, and control of soil erosion by proper utilization of so-called marginal lands. From a long-run standpoint, it contemplates a social and economic rehabilitation of the area largely through the decentralization of industry and the balancing of industry and agriculture.[1] From a power standpoint, the development of the hydro-power sites in the Tennessee Valley, with necessary supplemental steam plants, is a stupendous undertaking. The area coming under the sphere of the development covers most of western and central Tennessee, extends widely over northern Alabama, and includes portions of North and South Carolina, Georgia, Virginia, West Virginia, Kentucky, and Mississippi. The Authority is empowered to produce, distribute, and sell surplus power and it is authorized to lease or construct transmission lines and to contract with states, counties, municipalities, cooperative organizations, or private corporations for the sale of electricity for a period not to exceed 30 years.

Numerous enabling acts have been passed by the states concerned to permit political subdivisions to enter into contracts with the Tennessee Valley Authority. The first contract effected was a 20-year agreement with Tupelo, Mississippi. The Tennessee Valley Authority announced that certain rules and regulations, as contracted by Tupelo, would be made applicable to future contracts. These rules specify that the contractor agrees:

1. To administer its electric system as a separate department and not to mingle funds or accounts with those of any other of its operations.

[1] Martin G. Glaeser, *op. cit.*, gives a good historical summary of the Muscle Shoals development and the Tennessee Valley Authority Act. A later installment, found in *Public Utilities Fortnightly*, vol. XIII, No. 7, p. 394, 1934, summarizes the immediate and ultimate objectives of the program. For a similar description see also Ellis Kimble, The Tennessee Valley Project, *Journal of Land and Public Utility Economics*, vol. IX, No. 4, p. 325, 1933. The Nature and problems of planning for the development of the area are discussed in National Resources Committee, Regional Factors in National Planning, *Report*, December, 1935, pp. 83 *ff*.

2. To keep the electric-system accounts according to a system prescribed by the Tennessee Valley Authority which are to be uniform, so far as possible, for all municipalities.

3. To furnish operating and financial statements to the Tennessee Valley Authority.

4. To give to the Tennessee Valley Authority free access to books and records of accounts and operations.

5. To make the sale and distribution of electrical energy to the ultimate consumer without discrimination between consumers of the same class, and no rate shall be charged or practice adopted which will grant a discriminatory rate, rebate, or other special concession to any consumer; also, to observe the principle that the sale of energy for industrial uses shall be a secondary purpose, to be utilized principally to secure a sufficiently high load factor and reserve to permit domestic and rural use at the lowest possible rates and in such manner as to encourage increased domestic and rural use of electricity.[1]

Regulations covering the following points are also to be included in each contract:

1. *Tennessee Valley Authority Rates to Contractors.*—If at any time during the term of a contract, if rates for electricity supplied to another municipality by the Tennessee Valley Authority are lower than those covered by a given contract, and such lower rates cannot be justified by different conditions of service, such lower rates are to be extended to the contractor under the given contract.

2. *Resale Rates.*—Resale rates by the contractor are to be specified in each contract and there is to be no departure from such schedules without consent of the Tennessee Valley Authority.

3. *Development Surcharge.*—In order to maintain the contractor's reserves in the developmental period in which the increased demand for power may not be sufficient to compensate for the greatly reduced rates provided in the schedules specified in the contract, the contractor may impose a surcharge under the provisions of said schedule. All reserves over those required for appropriations in the contract shall be applied to the reduction and elimination of surcharges.

4. *Adjustment of Rates.*—Should the cost-of-living index compiled by the Department of Labor show a decrease for six consecutive calendar months of 20 per cent or more under the index figures for the month in which a contract is signed, the contractor may request that the Tennessee Valley Authority agree to a reduction in rates paid by it. Conversely, if the cost-of-living index should show an increase of 20 per cent or more for any period of six months above the index figures for the

[1] Quoted in *Electrical World*, vol. 102, p. 643, Nov. 18, 1933.

month of the contract, the Tennessee Valley Authority may request the contractor to consent to an increase in rates. In case no agreement can be reached within 30 days after such request by either party, it is provided that an arbitration board, composed of one member appointed by the Tennessee Valley Authority, one appointed by the contractor, and one selected jointly by the two appointed members, shall render a decision which will be final and binding upon both parties.

5. *Disposition of Contractor's Revenues.*—Revenues received by the contractor from its resale of electric energy are to be used first to cover operating expenses, and then, in the order named, to cover:

a. Interest and amortization on electric-system bonds or other indebtedness applicable to the system.

b. Reasonable reserves for new construction and other contingencies.

c. Payment to the general fund of the contractor an amount for taxes equivalent to the taxes assessed against other properties of a similar nature.

d. Return on contractor's equity of not more than 6 per cent per annum.

e. Reductions in rates to consumers.[1]

The Tennessee Valley power project has aroused no little opposition from private utility operators.[2] It is not illogical to assume that it will offer competition to many of the private operators in the area served and that eventually much business will be taken from them. Many municipalities have taken steps to be eligible and prepared for the purchase of power from the Authority, these steps involving the purchase of existing facilities from their private owners or the construction of competing facilities. The Authority has emphasized the desirability of purchase of existing facilities by cooperating local governmental agencies and several purchases, as that of the Knoxville properties of the Tennessee Public Service Company, have been made. Also, the Authority has entered into a contract with the Commonwealth and Southern Corporation, the

[1] *Op. cit.*

[2] For instances of these criticisms see: Doying, George E., Millions for Kilowatts, *Public Utilities Fortnightly*, vol. XV, No. 9, p. 443, 1935; Irwin, Will, The Great Tennessee Bubble, *ibid.*, vol. XI, No. 8, p. 439, 1933; Ely, Owen, The Yardstick Experiments, *ibid.*, vol. XV, No. 6, p. 285, 1935; Porter, J. H., Yardsticks, *ibid.*, vol. XV, No. 2, p. 74, 1935; Corey, Herbert, Is T.V.A. Telling the Truth? *ibid.*, vol. XV, No. 8, p. 391, 1935; and, Trying to Pry into T.V.A., *ibid.*, vol. XVI, No. 13, p. 801, 1935.

major holding company with operating subsidiaries in this area, and its subsidiaries providing for interchange of power and sale of land, transmission and distribution lines, substations, generating plants, etc., in a defined area. Many cited this contract as an evidence of a policy of confiscation of properties of privately owned utilities. Other observers, however, see in it an evidence of coordinated development of both private and public plants and one commentator states that this " . . . demonstrates that the Tennessee Valley Authority is minded to carry out the Congressional mandate without destroying the prudent investment in privately owned utilities and without inaugurating a policy of national economic waste in the duplication of power facilities."[1] Opposition to the power-development activities of the Authority resulted in a legal action questioning their constitutionality and, on appeal, was carried before the U. S. Supreme Court which, while not ruling upon the constitutionality of the Tennessee Valley Act as a whole, held that the Federal government may construct dams for purposes authorized by the Constitution such as for flood control, navigation, or national defense and that it may sell electricity generated at such dams.[2]

The general principles upon which the Tennessee Valley power developments are based are similar in many respects to those of the Ontario Hydro-Electric Power Commission in Canada. The Authority plans to limit its activities to the construction of power plants, generation, and transmission. Its sales are to be wholesale to local governments, cooperatives, and private utilities which will distribute the current for resale to ultimate customers. In such sales, consideration is given primarily to the benefits for the people of the section and particularly to the benefits for rural and domestic consumers to whom power can economically be made available. Sale of power for industrial purposes is a secondary consideration and is to be utilized principally to secure a high load factor as a means of keeping rates low for domestic and rural users. The Authority recog-

[1] GLAESER, MARTIN G., The Federal Government's Tennessee Valley Power Project—No. 3, Power Policy of T.V.A., *Public Utilities Fortnightly*, vol. XIII, No. 8, p. 456, 1934.

[2] *Ashwander v. T.V.A.*, 80 Law. Ed. Ad. Op., 427; decided Feb. 17, 1936. This question is again in litigation in *Tennessee Electric Power Co. v. T.V.A.*, U. S. Federal District Court for Northern Alabama, docket No. 904.

nized that the execution of the power program would cause conflicts between public and private interests and therefore announced that it would be guided by a policy stating, in part:

1. The interest of the public in the widest possible use of power is superior to any private interest. Where the private interest and the public interest conflict, the public interest must prevail.

2. Where there is a conflict between public interest and private interest which can be reconciled without injury to the public interest, such reconciliation should be made.

3. The fact that action by the Authority may have adverse economic effect upon a privately owned utility should be given serious consideration in framing and executing the power program. It is not, however, the determining factor. The most important considerations are the furthering of the public interest in making power available at the lowest rate consistent with sound financial policy and the accomplishment of the social objectives which low-cost power makes available.[1]

In its broader aspects, the Tennessee Valley Authority may be considered as the first concrete application of a national power policy which offers immediately the objectives of a more effective protection of the public interest by establishing a major public operation of power as a measure or "yardstick" for testing private operation, and greatly increased use of electricity in the homes, farms, and factories of the United States. These immediate objectives suggest a program for a national power policy which, as stated by David E. Lilienthal, Tennessee Valley Authority Director in charge of power, will involve the following points:

1. Thinking in terms of an electrified America and casting aside the tradition which binds us to our present niggardly use of electricity.

2. Reexamining and drastically revising the entire electric-rate structure.

3. Putting electric-using appliances into the homes and on the farms on a scale heretofore not successfully attempted.

4. Concentrating all the forces of business and scientific and engineering ingenuity and technique upon the problem of reducing certain of the costs of operation.

5. Bringing the people of the country to realize that there is a pool of electricity lying idle, ready, and waiting to be used, and to realize what

[1] Adapted from quotation in speech by Hon. John E. Rankin, *Congressional Record*, vol. 78, p. 2124.

electricity can do in lightening burdens, increasing incomes, and making for a richer and better life.[1]

The chief obstacle to the attainment of this ideal of the new national power policy seems to be the vicious circle of high costs of electricity, *i.e.*, high rates because of small use, and small use because of high rates. But some experiments indicate that this circle can be broken. An interesting experiment was performed by the Hartford Electric Light Company, which extended a one-third reduction in rates to its employees, with the result that average payments of this group were $3.83 per month, some 25 per cent more than the average payments of other domestic customers. This was accomplished in spite of the fact that as a group the employees earned a rate of 1.98 cents per kilowatt-hour, as compared to the general average rate of 4.5 cents per kilowatt-hour. It was broken on a more extensive scale 15 years ago in Canada by the simple expedient of making a very low price, one far below the then cost, and making up the deficits from industrial users and from taxes for the period required to obtain a larger use through the stimulus of a lower rate. To illustrate, there the average annual revenue per customer from high rates in 1915 was only $8, whereas from much lower rates in 1932 it was $30.[2] On a comparative basis, the average monthly use of electricity for domestic purposes in this country is slightly more than 50 kilowatt-hours while in Ontario it is more than 150 kilowatt-hours. Results of the early operations of the Tennessee Valley Authority indicate that here, too, lowered rates are promoting increased consumption. Service was started at Tupelo, Mississippi, in early 1934 on rates revised downward by an amount of more than 60 per cent. Figures for the first five full months of operation, March–July, 1934, show that residence consumption had increased 70 per cent and commercial consumption 53 per cent.[3]

[1] LILIENTHAL, D. E., Tennessee Valley Authority Seen Only as Spur to Electrification of America, *Electrical World*, vol. 102, pp. 687–690, Nov. 25, 1933.

[2] FERGUSON, S., How to Remove Popular Misunderstandings of Utilities, *Electrical World*, vol. 102, No. 23, pp. 729–731, 1933.

[3] GLAESER, MARTIN G., The Federal Government's Tennessee Valley Power Project—No. 4, Its National Significance, *Public Utilities Fortnightly*, vol. XV, No. 1, p. 9, 1935.

Continued success in this program will depend in part upon the more extensive use of appliances in building a higher average of consumption. This problem is particularly acute in the Tennessee Valley area where there is a large proportion of Negroes in the population whose incomes are comparatively low; where the population is relatively scattered which creates difficulties in obtaining volume sales of appliances; and where also the annual average spendable income is low, ranging from less than $119 in Mississippi to approximately $169 in Tennessee.[1] In order to overcome these difficulties and to promote the sale and use of appliances, there was established by executive order of President Roosevelt, December, 1933, the Electric Home and Farm Authority. This agency, popularly called the EHFA, acted as a financing subsidiary of the Tennessee Valley Authority and, through cooperation with both private and public utilities, appliance manufacturers, and dealers, and by financing sales and promoting educational and demonstration campaigns, has assisted materially in increasing the sale and use of low-cost but standard quality electric-using appliances.

The Tennessee Valley Authority is a significant development. In sharp contrast to the lack of planning, in both private and public power developments, which hitherto has prevailed in the United States, the Authority has based its program on economic and social planning designed to give a coordinated development of the power resources and natural resources of the area. The light which it will shed on moot questions, such as government ownership, also characterizes it as a significant development.

Electric Rates.—Before discussing electric rates, it will be profitable to refer again to the economies in production which accompany rate schedules adjusted to cause a more complete utilization of an existing plant and to promote the development of a larger sized plant. In the first instance, the fuller utilization of a given generating and distributing plant, regardless of its size, effects a lower per-unit cost of electrical energy. In the second instance, savings connected with larger sized plants operating with a high load factor, obtaining thereby economies of large-scale production, likewise effect a lower per-unit cost

[1] Curtice, Leon H., Tennessee Valley Electrical Appliance Problems, *Public Utilities Fortnightly*, vol. XIII, No. 8, p. 439, 1934.

of electrical energy.[1] Load factor is of special significance in the electric light and power industry because storage is not economically practical. Electrical energy is generated at the time of need and the capacity of a given plant must be large enough to meet the maximum momentary demand of its customers. Hence, the lower the load factor, the greater the amount of unused capacity in off-peak periods. Failure to utilize the plant continuously at its maximum capacity is unfortunate, moreover, because about two-thirds of the total cost of supplying electrical energy is independent of the amount of current generated. Since an increase in the off-peak consumption does not necessitate an enlargement in the plant, it aids materially in reducing the per-unit cost of energy generated.

The problem of developing a higher load factor as representative of a fuller utilization of the plant and lower per-unit costs of production has long been recognized in the electric light and power industry and rate schedules have been influenced thereby. It is largely in response to this influence that the electric light and power industry has developed rate schedules which are more nearly scientific than those in most other fields of the public utility business. The recent emphasis upon promotional rates is one manifestation of the influence of the load factor.

The actual determination of the peak load on the central station and the peak demand of the individual customer or group of customers involves difficulties. The maximum of the central station's peak load may extend over a considerable interval of time, possibly 30 minutes or longer, during which time changes in the load will be hardly determinable. But during such an interval, the use made by a given customer may vary within wide limits, from zero to 100 per cent.[2] Further, the actual determination of the peak demand, both in quantity and in time of use, is too costly except for groups or classes of customers such as light or power customers or for individual customers who use a large quantity of current, such as a street railway or a large industrial user. For practical application, if the rate schedule is to embody a demand charge for the customers who use only a small quantity of current, peak demands

[1] See p. 102 for a discussion of the economies of large-scale production.

[2] Eisenmenger, H. E., "Central Station Rates in Theory and Practice," p. 12, F. J. Drake & Company, Chicago, 1921.

may be determined by use of a maximum-demand meter, a demand limiter,[1] or it may be simply estimated on the basis of the meter capacity, connected load, or some proportion of connected load. However, these methods measure only peak demand of a customer and do not relate this demand to the time of the peak load on the central station. It is not justifiable to allocate a demand charge on this basis unless the customers are grouped into classes and given the benefit of the diversity factor.[2]

The types of rate schedules which have been designed to include the demand cost are the so-called two-part and three-part rates. Illustrative of the former are the Hopkinson rate schedule which has a separate charge for measured or computed demand and for energy and the Wright rate schedule which embodies a demand charge in the rate stated for different blocks of consumption, the blocks being based upon the number of hours' use of the demand measured in kilowatts rather than upon the number of kilowatt-hours consumed.[3] The Wright type of rate schedule is more widely used, especially for small consumers, than is the Hopkinson type. Three-part rate schedules, often called the Doherty rate, include a separate charge for energy costs, demand costs, and customer costs. This type of rate is seldom used. Its complexity tends to arouse consumer opposition and suspicion. Besides, it is not absolutely necessary to employ a three-part rate to have a theoretically scientific charge for electrical energy since practically the same results may be obtained by including a customer charge in the demand-charge portion of the Hopkinson rate and by using a minimum charge as a supplement to the Wright rate.

Once the demand costs have been allocated to individual customers or groups of customers, the load factor comes again into the picture. Thus, for a customer who makes use of his capacity only during off-peak periods, there need not be a demand charge assessable against him. These charges have already been allocated to the peak users and therefore the

[1] A meter device which automatically interrupts the current when the load on the meter is greater than that adjusted on the demand limiter and to which the customer demand charge is related.

[2] See Chap. II, p. 30.

[3] EISENMENGER, H. E., *op. cit.*, Sec. II; JONES, ELIOT and T. C. BIGHAM, *op. cit.*, Chap. VII; BARKER, HARRY, "Public Utility Rates," Chap. XV; and NASH, L. R., "Public Utility Rate Structures."

company would be justified in making a rate for off-peak use which included only the elements of the customer charge and the energy charge. It is obvious that the rate per kilowatt-hour in such a case would be relatively small. This emphasizes the importance of the time of consumption and the necessity of encouraging off-peak consumption to improve the central-station load factor. Increased consumption of energy affects costs in different ways. If it occurs at peak-load periods the effect is to increase per-unit costs by requiring a larger installed capacity. On the other hand, if the increased consumption takes place at off-peak periods, the effect is to decrease per-unit costs by spreading the fixed demand costs over a greater output.

Thus far, electric rates have been discussed primarily in terms of the elements of costs involved and the allocation of these costs to the individual users of the service. It was indicated, however, that to make such an allocation of demand costs for small customers would be a practical impossibility. The use of a demand-measuring meter is expensive and therefore justifiable only for the larger power users. It has, therefore, become common practice to group or classify customers on the basis of the amount of energy consumed, the nature of the use, or the time of the use. By such classification, customers may be grouped so that their load curves will be substantially similar. Material deviations from the load curve of the class will occur in some individual cases but practical justice to most of the consumers will result from the allocation of costs on the assumption that the class load curve is representative of the load curve of any customer of that class. A primary classification is between light and power customers and involves separate metering for current used for lighting and power used for motors or heavy-duty appliances. The number and nature of classes of customers, with rate schedules embodying cost allocation to each class, differ with companies but all adopt some or all of the following classifications for their services:

1. General lighting.
2. Residence lighting.
3. Commercial lighting.
4. Display lighting.
5. Street lighting.
6. General power.
7. Wholesale power.
8. Retail power.
9. Ice making.
10. Heating and cooking.
11. Primary or high-tension service.
12. Off-peak service.
13. Auxiliary, emergency, breakdown service.
14. Battery charging.

Promotional and Off-peak Rates.—The fact that generation and distribution of electrical energy must be simultaneous has compelled the electrical industry to pay particular attention to its load factor and to take steps to bring about improvements therein as a means of reducing unit costs. One finds, therefore, a quite general development of promotional, off-peak, and special rates in this field.

For large power consumers, it is often economically feasible to measure the actual demand and the time when the given customer's peak demand occurs. Low rates for favorable load factors can be offered and still greater concessions can be made for energy used at off-peak times since such energy, as already explained, does not necessitate additional investment in plant and equipment in order to supply it. Any amount which it returns over and above its actual energy and customer costs is a contribution which actually decreases the company's per-unit costs of output. In other cases, the demand of a customer in this class is estimated and the rate schedule is designed to meet the particular conditions encountered. The Wright and the Hopkinson types of rate structures are particularly adapted to these uses.

Promotional rates are those which are made with a view to encouraging, stimulating or inducing a greater use of service. The expedient followed is the offering of a low rate with the expectation that the revenues from resulting increased consumption will make the service profitable to the company. As such, promotional rates can be offered for any specified service, such as water heating; to any combination of services, such as lighting with cooking; and to any class of customers, as ice making or off-peak service. In general, off-peak or special rates are offered for domestic services which employ the so-called heavy-duty appliances and to industrial users who limit their use to off-peak periods.

As originally conceived for domestic application promotional rates were usually offered for a given service only, such as water heating, but many difficulties were encountered. Water heaters fall into two classes for rate-making purposes: those having unlimited use of energy and those having energy use restricted to particular periods. The former type uses a small tank with a large heating element and the latter uses a larger tank with a

smaller heating element. From a rate-making standpoint, the unlimited type has a high individual demand, frequently coinciding with customer and system peaks. The restricted service has the advantage (to the company) of energy consumption limited to off-peak hours. The customer, however, is likely to find that restricted service is less satisfactory because of higher initial cost of installation, greater radiation losses, and lack of flexibility in meeting unusual demands for hot water or other restricted services. To offer promotional rates for unrestricted services might prove costly to the company in requiring additional plant capacity to meet an enlarged peak demand.

In recent years, however, both consumption of electrical energy and revenues have been brought to the fore. At the same time, public consciousness of rates for electrical energy has become greater as the publicity of the Tennessee Valley Authority development has emphasized both lower rates and increased consumption. Many companies, as a solution to this problem, have decided to offer promotional rates for all domestic services with the hope of stimulating marked increases in consumption, modeled in part on the Tennessee Valley Authority plan. This development has generally been called the "Objective Rate Plan" which usually offers an immediate reduction in rates plus a further and permanent reduction for those customers who increase their consumption over a selected base period, usually the corresponding month in the preceding year. The revenues of the company probably will not be substantially reduced by the initial offering of the lower rate and, as the many small users are induced to increase consumption, the total revenues of the company may be materially increased while the consumers get the benefit of a much lower rate per kilowatt-hour of consumption. The plan has been very successful in some cases.[1] In all these instances and, in

[1] For detailed instances of application and problems involved, see: Morrow, L. W. W., Sales Mount in Georgia, *Electrical World*, vol. 105, No. 14, July 6, 1935, p. 32; Selling—the Way Out, *ibid.*, June 22, 1935, p. 23; Newton, Frank A., Recommends Objective Rate, *ibid.*, June 8, 1935, p. 62; Zinder, H., and Walter E. Caine, Bargain Sales of Electricity, *Public Utilities Fortnightly*, vol. XV, No. 12, June 6, 1935, p. 691; Courtright, H. H., It's Free to You, Sir, *ibid.*, July 19, 1934, p. 90; A Follow-up on the Free Electricity Experiment, *ibid.*, Nov. 8, 1934, p. 589; and Adams, W. C., The Objective Rate Plan, *ibid.*, Nov. 7, 1935, p. 631.

general, for a promotional rate for domestic consumers to be successful, it must be accompanied by an active appliance-sales and appliance-using program.

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CHAPTER V

WATER-SUPPLY UTILITIES

In point of time, water supply is the oldest of the public utilities. Its history dates back to very early times with important wells and storage systems being developed in Egypt, Greece, Assyria, Persia, India, China, and Rome. The Roman water-supply system, dating from 312 B.C., with aqueducts of an aggregate length of 359 miles, was the most extensive development of this early period. During the Middle Ages, following the fall and decay of Rome, there was general neglect of the entire subject of water supplies and but few cities were scantily supplied with water.[1] It was not until the seventeenth and eighteenth centuries that any progress could be noted and even then it was slow. The development of modern waterworks in Europe, however, dates from the beginnings made at this time.

Development of Waterworks in the United States.—The first water-supply system in the United States was located in Boston, a spring supply of water being piped by gravity to that city in 1652. The first pump system was installed at Bethlehem, Pennsylvania, in 1754. Wood pipe was used in this system as was true of the other early systems. The first use of a steam engine for pumping water occurred at Philadelphia in 1800, taking water from the Schuylkill River. The Philadelphia system can be characterized as the first modern waterworks since it also initiated the use of cast-iron pipes, these being laid in 1804. There were 16 public water-supply systems in the United States by 1800. Following 1850, the development of public water supplies

> . . . in the United States was very rapid particularly with reference to enlargement of supplies, improvements in machinery and materials, and the construction of works in smaller communities not previously supplied. Among the more important improvements were the perfec-

[1] For a more detailed summary of the history of waterworks, see F. E. Turneaure and H. L. Russell, "Public Water Supplies," pp. 1–11.

> tion of cast-iron pipe; the improvement of pumping machinery, whereby the duty was very greatly increased; the manufacture of the smaller pumps on a commercial scale, thus greatly reducing the cost to small towns; the adoption of direct pumping systems for small towns, thus also in many instances reducing first cost; the development of the ground and artesian water supplies in the western states. By 1900 it was rare to find a village of 2,000 inhabitants without a public supply.[1]

The number of waterworks had increased to 3,196 by 1896, over half of which (53.2 per cent) were publicly owned.[2] Since 1900, the most important development has been improvement in the quality of water by purification and by taste and odor removal. There also has been improvement in operation practices, notably in the elimination of wastes.

Present Status of the Water-supply Utilities in the United States.—Statistical data covering the water-supply industry are incomplete and uncoordinated. It is therefore difficult to make an accurate analysis of the present status and extent of waterworks systems in the United States. The available data, however, do indicate satisfactorily the conditions existing in the industry.

A survey, made by *Public Works* in 1927, covered 900 of the 1,400 towns of 2,000 to 5,000 population in the United States, and 728 of the 1,467 cities having a population of 5,000 or more. On the basis of this extensive sample it was estimated that there were 9,800 waterworks systems in the United States. This estimate included all sizes, some of which were very small, such as summer-hotel and camp supplies. The number of waterworks sufficiently large to be of commercial importance was estimated to be about 3,000. Of this number, about 70 per cent were municipally owned and 30 per cent privately owned. Further estimates made from this survey showed:

1. Services: Approximately 7,000,000 services in use.
2. Meters: Cities of 5,000 and over had in use 4,775,000 meters and the smaller cities and towns had about 225,000 meters.
3. Hydrants: There were in use in 2,787 municipalities a total of 650,000 fire hydrants.[3]

[1] *Op. cit.*, p. 8; see also "Manual of Water Works Practice," pp. 1–11.
[2] "Manual of American Water Works," 1897, Table I, p. G.
[3] Some Water Works Data, *Public Works*, vol. 59, p. 475, December, 1928.

The *Magazine of Wall Street* estimated for 1929 that there were 8,000 communities in the United States with organized waterworks. Approximately 75 per cent of these were believed to be municipally owned with an estimated capital investment of $2,700,000,000. The 25 per cent privately owned systems had an estimated capital investment of $900,000,000. It is worth noting that this estimate points out that there has been a large increase in the privately owned systems in the small and medium-sized cities in recent years,[1] a conclusion contrary to that of other observers who note an increase in the trend toward municipal ownership of water-supply systems.

The National Resources Board, in its report dated December 1, 1934, states that there are about 7,100 public water-supply systems in the United States which serve over 80,000,000 people who use over one billion cubic feet of water daily. It is estimated that 80 per cent of the users are supplied from publicly owned systems and that during the last 25 years there has been a marked trend toward the extension of municipal ownership.[2]

Economic Characteristics of the Water-supply Industry.— The economic phases of the water-supply industry are profoundly affected by the social phases. An adequate supply of water is an absolute necessity. It is equally important that the water be pure, that is, free from disease-producing organisms. The modern city, whether large or small, needs water for fire protection, sewage disposal, and flushing. The water-supply system may go further than these essentials and provide soft water in place of hard water, and water free from disagreeable tastes, odors, and colors. The effect of these considerations on waterworks practices will become apparent as the discussion of this chapter develops.

The uses of water are generally known. In domestic uses, such as drinking, cooking, washing, and laundering, the factor of purity is of utmost importance. Color, turbidity, taste, and softness are also important. For fire protection, quantity and pressure are the controlling considerations. The water used in industrial processes must be free from color, turbidity, hardness, and chemical salts and acids. Inability to obtain water with

[1] HARTWELL, RONALD P., Water—A Growing Utility, *Magazine of Wall Street*, vol. 46, p. 398, June 28, 1930.

[2] National Resources Board, *Report*, Dec. 1, 1934, pp. 331–332.

these requisite qualities from public supplies has made it necessary for many industries to provide themselves with a private supply of water.

The sources of water supply may be divided into the following general groups:[1]

1. Surface waters:
   a. Rain water collected from roofs.
   b. Water from rivers.
   c. Water from natural lakes.
   d. Water collected in impounding reservoirs from drainage areas.
2. Ground waters:
   a. Water from springs.
   b. Water from shallow, deep, and artesian wells.
   c. Water from horizontal galleries.

The source of the water supply directly affects construction and operating costs of the waterworks and the nature of the water affects operating practices concerning purity, color, taste, and so on. Uneconomical operation, high maintenance cost, and ultimate abandonment have frequently resulted from failure to thoroughly investigate the source of supply before undertaking construction of the plant. A satisfactory source of supply has the following characteristics:

1. Adequacy of the supply for future enlargement and expansion.

2. Freedom from pollution and contamination.

3. Favorable development or construction costs as compared with other possible sites and sources.

4. Favorable operating costs as compared with other possible sites and sources.[2]

Approximately three-fourths of the public water supplies are obtained from surface water. Water of satisfactory quality can be obtained almost anywhere in the United States, except in desert areas, by proper treatment of near-by river or lake water or by impounding the runoff of distant watersheds.[3] In the case of some larger cities, it has been necessary to make use of distant sources of supply as illustrated by:

[1] TURNEAURE and RUSSELL, *op. cit.*, p. 38.
[2] "Municipal Index," 1924, p. 300.
[3] National Resources Board, *op. cit.*, p. 330.

	Miles
Los Angeles, proposed from Colorado River	280
Los Angeles, now using Owens Valley	150
San Francisco	170
New York	125
Boston	75
Tulsa	70

Contamination and pollution are problems which must be considered in connection with the source of the supply. Pollution occurs commonly from sewage, slaughterhouse wastes, and other putrescible wastes. The danger of pollution and the subsequent spread of disease must be guarded against. Contamination of water is usually traceable to industrial or mine wastes which make the water unpalatable and sometimes unfit for certain domestic and industrial uses. Color-, taste-, and odor-removal operations are necessary as long as the wastes contaminate the supply. There has been a noticeable tendency to abandon supplies obtained from heavily polluted sources and to develop new supplies from less polluted sources. This frequently involves the expenditure of large sums of money as the recent $7,000,000 investment made by Albany, New York, when it ceased using water from the Hudson River. In the case of many of the larger cities and for the smaller cities, resort must be made to elaborate purification and treatment of unsatisfactory surface-water supplies.[1]

The consumption of water in the United States varies from 15 to 300 gal. per capita per day. This wide variation is due to a number of factors, such as age of the distribution system, care in detecting and preventing leaks in the distribution system, daily and seasonal temperature changes, metering of supplies, industrial uses, public uses, sewage disposal, pressure in the distribution main, and wastes by users.

Probably the most significant items in the above list are wastes and metering. The elimination of wastes in the distribution system has a marked effect on consumption figures. This is also true of wastes by consumers since small wastes and leaks in domestic equipment become great in the aggregate. The metering of water supplies has a pronounced effect. In places where all supplies are metered, the figures for daily consumption usually lie between 15 and 50 gal. per capita.

[1] *Op. cit.*

Unmetered consumption figures will range from 30 to 200 per cent greater than those in metered service.[1]

Ownership is one of the distinguishing features of the water-supply industry. Public, usually municipal, ownership is the rule rather than the exception. The reverse holds true in the other public utility industries. All estimates give the proportion of municipally owned waterworks as 70 per cent or greater. The trend toward municipal ownership has been steady and consistent since the beginning of the nineteenth century when only one of the 16 existing plants was municipally owned. The predominance of municipal ownership can be accounted for by the economic necessity for a water supply, the need for fire protection, and by sanitary and hygienic considerations. It is currently believed by many that sanitary and hygienic considerations forced municipalities into supplying water. While this has been a contributing and important factor, it did not become significant until late in the nineteenth century. On the other hand, works for impounding and distributing a water supply require a relatively large capital investment and extensive use of the power of eminent domain. Coupled with this situation was the attitude on the part of many that water was free and therefore should be supplied with a minimum of cost to the user. Privately owned waterworks, therefore, encountered difficulties in charging rates sufficiently high to cover costs while the municipalities found it possible to shift some of the costs of construction to property owners by assessment and some of the current costs of operation to the taxpayers in the form of taxes. It can easily be seen how this situation becomes conducive to municipal ownership.

The majority of the publicly owned systems have been efficiently managed, as indicated by the quality of water delivered to consumers, the services rendered, and the rates charged.[2] The administration of the waterworks system has, however, frequently been motivated by political rather than business motives.

[1] "Municipal Index," 1924, p. 300.

[2] National Resources Board, *op. cit.*, p. 332. For an illustration of the operation of large municipal systems see James Blaine Walker, A Gigantic Municipal Utility, *Public Utilities Fortnightly*, vol. XVI, No. 13, p. 810, 1935.

It is obvious that a business, rather than a political, administration is the only sound and desirable form of administration for municipally owned and operated public utilities. The all too-frequent uneconomical operation, failure to adopt improved devices, failure to carry out improved operating practices, failure to properly maintain the plant, failure to provide depreciation and replacement reserves, resulting of course in deserved criticisms, are found in the operation and control of these utilities by a political management with selfish ends in view. Administration independent of close political control is the only remedy for this situation.

Some Water-supply Utility Problems. 1. *Finances.*—One of the most pertinent problems in the municipally owned water-supply system relates to the financial relationship beween the utility and the city. In those municipally owned utilities which are managed by independent boards, commissions, or other similar agencies free from political control, the financial operations of the utility seem to be generally satisfactory. Segregation of utility and city finances usually occurs in such cases and the utility builds up the proper depreciation and replacement reserves before computing the profits (or losses) from its operations. But many of the city-owned waterworks are operated as city departments by political appointees or elected officials who change with each administration. The waterworks system in many of these is a political football and the utility's finances are a plum to be plucked for the city's general fund. There is usually no segregation between the finances of the city and its water utility and the utility is usually the one to suffer. Profits of the utility are merged into the city's general fund and such profits are usually computed without reference to the utility's need for depreciation and replacement reserves. It is obvious that the financial predicament of the utility in such cases will go from bad to worse and become a burden to both the taxpayers and the customers. The American Water Works Association has been active in attempting to bring about segregation between the cities' and the utilities' financial operations and some substantial progress has been made.[1]

[1] For instance, see Lawrence M. Bailey, Water Financing in Small Cities, *Journal American Water Works Association*, vol. 22, pp. 257–258, April, 1930.

One special financial problem of the water utilities has to do with extensions since the waterworks are constantly subject to requests for extension of their mains, often into sparsely settled territory. The utility, of course, has assumed an obligation to render adequate service so each extension must be analyzed in that light. Some municipally owned systems are limited by law to the boundaries of the city and some of the privately owned systems are likewise limited by franchise provisions. In either event, the only ways in which extensions outside of the city limits can be made are through a separate company or through specially organized water districts. Neither alternative will be considered unless the territory to be served is relatively densely populated. When there are no such legal or franchise limitations,

. . . long and expensive extensions serving only a few people, which are of no benefit to the community as a whole and which for a long period of time do not yield sufficient revenue to cover the full cost of the service, should ordinarily not be built if they would add to the cost of serving existing customers or cause the returns to the owners of the property to fall below a reasonable limit. On the other hand, the normal water utility should expect to maintain a standard of rates which will permit temporarily unprofitable extensions from time to time when the burden of these extensions distributed over the business as a whole is small.[1]

Methods of financing extensions are numerous. A survey

. . . in 616 municipal plants and 153 private plants carried on by the *American City* shows some interesting facts. Of the municipal plants, 202 finance extensions from current earnings or revenue; 202 finance extensions through department funds, a general tax, or direct from the city treasury; 155 finance extensions from bond issues; and 57 through assessments levied on those benefited. Of the 153 private plants, 33 finance extensions from current income; 91 from general company funds or surplus revenue; 20 through the issuance of stock or bonds; 3 require the consumers to pay the costs; and 6 state that the cities themselves finance all extensions, the company only furnishing the water.[2]

[1] MICHAELS, A. P., Problems in Water Utility Finance, *Journal American Water Works Association*, vol. 23, pp. 708–715, May, 1931; see also "Manual of Water Works Practice," pp. 545 *ff*.

[2] "Municipal Index," 1924, p. 313.

This problem has also been handled by commission rulings. The California commission requires that estimated annual revenues must be at least one-fourth the cost of the extension before it can be made. The New Jersey commission requires the real estate owners or promoters to deposit the full cost of the extension which is returned at the rate of $3.50 per each $1 of annual gross revenue. The tendency in financing extensions now seems to be toward plans similar to the last two stated.[1]

2. *The Pumping Station: Prime Movers.*—Prime movers or power used in waterworks service is important since its cost, amounting from one-fourth to two-thirds of the total operating costs, is one of the major items in the operating expense of waterworks. It also affects reliability of service. Steam was originally used as the motive power for the pumps. Since 1900, electric power plants and transmission lines have been constructed so that electrical power is now competing with steam and displacing it in many plants. Gasoline engines are used satisfactorily in some very small plants. In recent years, many Diesel engines have been installed because of certain advantages which they offer, such as: (1) ability to start from cold at a moment's notice; (2) ability to operate for long periods of time without a shutdown, 100- to 200-day runs being common; and (3) low fuel cost. Experience is demonstrating that the field for prime movers can be divided into three groups: (1) where there is pumpage at a nearly uniform rate, steam is economical if the load calls for turbines of 1,500 or more horsepower capacity; (2) for similar plants with loads averaging less than 250 horsepower, the electric plant will be most economical unless the power rates are unduly high; and (3) in between is a competitive field in which the Diesel has a slight advantage.[2] Table 15 shows the comparative costs of these three types of prime movers for a plant which had changed from steam to Diesel operation.[3]

3. *The Distribution System.*—In general, the distribution system should be composed of pipes of sufficient size for the

[1] MICHAELS, *op. cit.*, pp. 708–715.

[2] BALDWIN, R. L., Diesel Engines for Water Works, *Journal American Water Works Association*, vol. 22, pp. 157–165, February, 1930.

[3] COUCH, A. D., Economy and Reliability of Diesel Engines, *Public Works*, vol. 60, pp. 382–383, October, 1929.

ordinary needs of the community and for fire protection. In no case should the main pipes be less than 8 in. in diameter if fire hydrants are to be installed. Allowance should be made for a short-time consumption of about three times the average consumption. The pressure should be between 45 and 100 lb. per square inch and preferably from 60 to 80 lb. per square inch. A pressure of less than 45 lb. is inadequate for fire protection and one greater than 100 lb. causes considerable leakage in mains

TABLE 15.—COMPARATIVE COSTS OF STEAM, ELECTRIC, AND DIESEL OPERATION

Yearly cost

Item	Steam*	Electric†	Diesel‡	Diesel§
Coal, power or fuel oil	$ 12,869	$ 22,560	$ 7,710	$ 7,336
Lubrication	800	....	420	496
Engine repair	1,000	....	400	172
Pump repair	(in above)	200	150	
Labor	13,775	6,000	7,880	5,396
Supplies	1,000	....	250	398
Operating total	28,944	28,760	16,730	13,798
First cost, less building	....	7,100	43,500	43,000
Fixed charges at 15 per cent	....	1,065	6,525	6,450
Operating costs plus fixed charges	....	29,825	23,255	20,248
Million gallons daily	800	800	800	923
Av. ft. head	335	335	335	309
Million ft.-lb	2,220,000	2,220,000	2,220,000	2,462,044
Operating cost per million ft.-lb.	$0.01304	$0.01295	$0.00754	$0.00560

* Five-year average.

† Estimated.

‡ Estimated.

§ Actual, first year.

and fixtures unless costly and heavy plumbing is used. Dead ends in distribution mains should be eliminated so far as possible by interconnection with other dead ends or parts of the main.[1]

4. *Water Purification and Treatment.*—Satisfactory water is entirely free from pathogenic bacteria and reasonably free from any bacteria. It must also be suitable in taste, odor, color, turbidity, and softness. It is seldom that raw water offers satisfaction in these respects, so many of the water-supply systems purify or otherwise treat the water before delivering it

[1] "Municipal Index," 1924, p. 303.

to the distribution mains; and it is economically desirable that this be done. Purification is a health measure designed to prevent the spread of water-borne diseases; taste and odor removal prevents the development of dissatisfaction and subsequent complaint by the users; eliminating hardness gives more desirable water and eliminates the comparatively high cost incurred when a consumer has his individual supply of water softened.

Over one-half of the public water-supply systems deliver untreated water to their customers. Many of the remainder supply water which has been treated only with chlorine as a purification measure. The remaining systems practice filtration which is usually followed by chlorination.[1] Purification practices are generally one or a combination of the following:

1. Settling or sedimentation—this is accomplished by slow flowing or the standing of water in tanks and reservoirs. The chief result obtained is an improvement in turbidity, *i.e.*, physical appearance of the water. It is but slightly beneficial in bacterial removal.
2. Coagulation with chemicals—usually alum or iron is used to assist with the sedimentation process.
3. Filtration—the water is allowed to seep through beds of sand which removes about 99 per cent of the bacteria and practically all the color. A bed about 30 in. thick and 18 by 20 ft. in size will filter a million gallons of water daily.
4. Chlorination—the injection of about one-half pound of liquid chlorine per million gallons of water is the usual dose. Following filtration, it is very effective in bacterial control. Because of the fluctuation in the character and quality of raw water and because of a possible breakdown in the mechanical equipment, dependence upon chlorination alone is not satisfactory.[2]

The presence of tastes and odors is usually directly attributable to wastes emptied into the source of the water supply. In addition, some organisms which live in water cause distinct tastes and odors. For industrial uses, removal of taste and odor is necessary; for domestic uses, their removal means the elimination of a source of dissatisfaction and complaint. The methods used for taste and odor removal include:

[1] National Resources Board, *op. cit.*, p. 331.

[2] *Ibid.* See also The Why and How of Water Purification, *Public Works*, vol. 62, pp. 15 *ff.*, September, 1931, and "Manual of Water Works Practice," Chaps. VI–XII.

1. Aeration—this is one of the oldest methods employed and has wide application. It is not effective alone but does remove the tastes and odors caused by organisms in the water when followed by filtration. It does not remove the very disagreeable tastes and odors caused by the phenolic wastes from coal by-products plants, creosoting works, and gas plants.
2. Addition of chemicals—a solution of copper sulphate is frequently placed in water supplies to kill or inhibit the growth of organisms and thus lessen tastes and odors. The technique of application is important. For the elimination of tastes and odors caused by the phenolic wastes, mentioned above, super-chlorination followed by dechlorination or ammonation with chlorination are effective. It has recently been found that active carbon compounds, when placed in the water supply, absorb both phenol and chlorine compounds, thereby eliminating tastes and odors.[1]

While known for many years, water-softening treatment in public water supplies has been practiced only in recent years. Water softening by the waterworks plant is justifiable on grounds of cost. A pound of lime, costing approximately one-half cent, will soften more water than 20 pounds of soap. Users of hard water find their soap bill to be from 67 per cent to 437 per cent greater than that of soft-water users.[2] A temporary hardness, removable by boiling, is caused by calcium bicarbonate and magnesium bicarbonate. Permanent hardness, requiring chemicals to remove it, is caused by calcium sulphate and magnesium sulphate. The most common water-softening treatment is the injection of lime or lime soda and ash. The cost of this treatment will vary approximately between 2½ and 5½ cents per 1,000 gal. of water, depending upon its hardness. Since most water supplies are to some degree hard and since only a few plants, some 150, practice softening, it would be desirable and economical for this practice to become more general.[3]

5. *Metering, Meters, and Meter Reading.*—The use of water meters on main supply lines, pumps, distribution reservoirs, and domestic and industrial services is the only proper method of

[1] HANSEN, PAUL, Taste and Odors in Public Water Supplies, *Journal American Water Works Association*, vol. 23, pp. 1495–1503, October, 1931.

[2] HOOVER, CHARLES P., Municipal Water Softening Versus Domestic, *Public Works*, vol. 62, p. 34, December, 1930.

[3] HOWSON, L. R., Municipal Water Softening, "Municipal Index," 1932, pp. 314–318.

determining the amount of water distributed and consumed. "The effect of meters on consumption," a study of Ohio conditions shows, "is that the average daily consumption for 100 per cent metered cities and villages in Ohio is 90 gal. and the average daily consumption for cities and villages without meters is 170 gal. For cities alone, the average daily consumption for 100 per cent metered cities is 100 gal., and 170 gal. per capita for cities without meters."[1]

Domestic and industrial services are metered because it is the only known way to prevent needless waste and because sale by measurement is the only logical way to prevent gross inequalities and discrimination against some consumers and in favor of others. It has frequently been the case that cities and towns which charged flat rates have faced the alternatives of securing a new and larger supply of water or eliminating undue waste of the present supply. The installation of meters, with a consequent elimination of waste, disclosed that the present supply was ample to care for the needs of the city for years to come. Meter installation costs are only a fraction of the costs usually incurred in developing a new source of supply. Customers, too, appreciate the fact that charges based upon measurement eliminate many discriminations.[2]

Small leaks are common in unmetered services. They occur in such ways as leaking toilets and fixtures, broken underground pipe, defective stop and waste cocks, needless use of water, and the like. A leak of ½ gal. per minute amounts to 720 gal. per day and 262,800 gal. per year. Many such leaks, accordingly, constitute a serious drain on the water supply. When meters are installed, the consumers realize that they pay for these leaks and wastes and therefore take steps to prevent them.[3]

The only way in which water wastes can be determined accurately is by metering both the main supply going into the distribution mains and the amounts taken out of the mains by customers. On the basis of a survey of water-supply systems

[1] "Municipal Index," 1924, p. 311.

[2] *Ibid.* See also *American City*, vol. XLIX, January–May, 1934, for instances of waste prevention by metering.

[3] VANNOY, F. R., Conservation by Metering, *Journal American Water Works Association*, vol. 23, pp. 276–279, February, 1931.

published in 1925 by the *American City* magazine and the "Municipal Index," it would appear that many water-supply systems are incompletely metered and therefore do not know the extent to which wastes and leaks occur. This survey found that only about one-fourth of the systems have their main supply metered and that only one-third have their domestic services completely metered, the remainder of the domestic services being unmetered or only partially metered.[1] In recent years, however, many systems have installed meters for all their services.

It was almost a universal practice, in the earlier days of the development of the water-supply industry, to require the users of the service to own the meters; but in view of the fact that the meters had to be maintained and repaired by the company, which usually encountered difficulties in collecting the charges for this service, it has been found desirable for the ownership of the meters to be vested in the company. This practice is now generally followed.

Meter reading is one of the important functions in the conduct of the waterworks business. Its importance lies not so much in the fact that technical skill is required for the readings but in the fact that the meter reader is one of the few company officials who comes in contact with the consumer. Tact and courtesy on the part of the meter reader are requisite qualities. The work of the company in developing satisfactory customer relationships is facilitated by the meter reader who studies the needs of each customer and checks the meter reading against this. Any marked variations lead to investigations. The duties of the meter reader may be summarized as follows:

1. Reading the meter.
2. Making investigations to determine the cause of high consumption.
3. Testing meters.
4. Locating consumers who vacate premises without giving shutoff orders.
5. Inspection of occupied dwellings where meters are listed as shut off.

[1] Adapted from statistics reported by *American City*, February–July, 1925, and "Municipal Index," 1925, pp. 378–409.

6. Making take-out and test tickets for meters which show a registration of a specified total amount of water.[1]

Legal Responsibility for Pure Water.—Both privately and publicly owned water-supply systems are legally responsible to supply water free from impurities. The measure of responsibility is stated in several court decisions, a typical statement being:

> . . . Negligently furnishing water which is deleterious to the human body or health will furnish a valid cause of action to a customer injured by the use of the water. Actual notice or knowledge of the unwholesomeness of the water of the defendant company was not an essential element to be proven in order to establish the defendant's liability; it was sufficient if there was testimony to show that the defendant, in the exercise of reasonable care, might have discovered the unwholesomeness and dangerous conditions of the water.[2]

In view of this, most state laws or public service commissions have established standards of purity for water and require that water analysis be made at regular intervals. Suitable analyses, including both chemical and bacteriological examinations, should be carried out at every point in the waterworks. Accurate records should be kept since the control of purification of the water supply must be based upon past experience.

Fire Protection and Water Supplies.—A large proportion of the investment in the plant and equipment for the waterworks system is attributable directly to the fire-protection services. The "Manual of Water Works Practice" states:

> . . . Experience has shown that the cost of the portion of the waterworks involved by fire-protection service in this country generally constitutes 60 to 80 per cent of the entire cost of the physical property in the case of communities having less that 10,000 population, 30 to 40 per cent in communities of about 50,000 population, 20 to 30 per cent in communities of about 100,000 population, and 10 to 20 per cent in case of our largest cities.[3]

[1] SHIVELY, L. D., Efficiency in Meter Reading, *Journal American Water Works Association*, vol. 23, pp. 820–825, June, 1931.

[2] *Jones v. Mount Holly Water Co.*, 93 Atlantic Reporter 86. See also *Canavan v. City of Mechanicsville*, 28 Northwestern Reporter 158; *Green v. Ashland Water Co.*, 77 Northwestern Reporter 722.

[3] At p. 593; quoted in G. H. Fenkell, Management of a Water Works Business, *Journal of the American Water Works Association*, vol. 20, p. 315, 1928.

The design and size of the waterworks system are materially influenced by the needs of the fire-protection service, since the quantity of water needed for the fire flow must be provided. Though this creates no special problem in the supply of water needed except for the smaller systems, it does create a distinct problem in providing distribution mains of sufficient capacity to allow the water flow to be concentrated. It is also true that the fire-flow needs must be provided in excess of the maximum needs for domestic consumption. If this is not done, a serious deficiency in water flow for fire protection would result if the domestic peak load and fire load happened to coincide. Domestic consumption can be curtailed to some extent during times when the flow is needed for fire protection but it cannot be curtailed extensively without hardships on the domestic consumers. The experiences of Indianapolis, a city of between 300,000 and 400,000 population, illustrates the influence of the demand for fire-protection services on the distribution mains. Average daily consumption there is about 35 million gallons. Without fire services, the mains could be constructed to handle a maximum daily consumption of 55 million gallons. Fire-flow demands, however, impose an additional demand for 23 million gallons so that the distribution-system capacity required is 78 million gallons daily.[1]

Pressure of the water in the mains to insure adequate flow for the fire services must also be provided. Pressure for fire-flow services must be materially higher than the pressure necessary and desirable for domestic services, so the addition of fire-service load to the domestic load requires that minimum pressure be maintained at a figure higher than otherwise would be necessary. If the pressures needed are to be raised by the pumping plant of the waterworks system, there must be kept in readiness pumping capacity which can be started on a moment's notice. Keeping steam boilers fired for this purpose is too expensive so auxiliary gasoline, Diesel, or electric pumpers are provided. Experience has proven, however, that cheaper and more satisfactory results can be provided by fire-engine pumpers. If the water-supply system is a direct-pump system, pumping

[1] Goldsmith, Clarence, Municipal Waterworks Systems and Fire Protection, *Journal of the American Water Works Association*, vol. 21, pp. 169 *ff.*, February, 1929.

capacity must be large enough to maintain needed pressure even though several of the pumping units may be out of service. Elevated storage, providing a supply for several hours' fire flow, relieves the demand on pumping capacity.[1]

Hydrants for fire flow must also be provided and their location determined. Cost of hydrants is thus a matter to be considered, and if paid by the waterworks, this cost must be included in the investment for the plant and equipment.[1]

It is apparent that charges or rates for fire-protection services must receive careful consideration. If fire services are rendered free of charge, as is frequently the case, the burden of its cost falls upon the other water users and results in higher rates to them. If the rates are based upon the amount of water consumed, the fire service pays but a small proportion of the costs since it consumes only about 1 per cent or less of the total water supplied by the waterworks. It follows, then, that the only logical basis for apportioning charges against the fire service is to make a demand or service charge which is commensurate with the proportion of the costs necessitated by these services. This view is being supported by commission decisions.

It has been indicated that where fire-protection services are rendered free or are based upon consumption, the cost thereof, or a part of it, is borne by the other water users in the form of higher rates. When the fire services are adequately paid for, the cost is borne by the taxpayers in the form of higher taxes. Probably one reason for the continuation of the practice of free fire service or fire service rendered at much less than its real cost is the greater ease of collecting from the users than from the taxpayers. One need only cite the rising tide of protest against increased taxes to offer support for this view. It is coming to be an established principle in public utilities, however, that the charge for a service should be commensurate with its cost. The tendency seems to be toward making charges for fire services which are more closely related to their costs. It is a decision which determines how much of the burden of the fire-service cost should be borne by the taxpayers at large, *i.e.*, the owners of the property protected, and the water users. In order to equalize this burden Kansas requires by law that all

[1] *Op. cit.*

property pay for fire-protection services as well as for water services.

A consideration of the value of the fire service will throw light upon this question of distributing the costs for the fire service between the taxpayer and the water user. Savings in fire insurance rates to the benefit of the property owner offer a criterion of the value of this service. The National Fire Underwriters Association, in determining basic rates for fire insurance, follows a system of demerits. The demerit schedule is:

Water-supply system	1,700
Fire department	1,500
Fire alarm system	550
Police system	50
Building laws	200
Hazards	300
Structural conditions	700
Total demerits possible	5,000

Thus, out of a possible 5,000 demerits, water supply is assigned the single largest amount—1,700. It can be seen, therefore, that adequate water supplies lower the demerit rating and thus lower the base insurance premium for a given municipality. It has been calculated by one commentator that average insurance rates are 2.46 per cent of the value of the property in Nevada and 0.82 per cent in New York. If half of this difference, as he believes, is attributable to the water-supply rating, one-half of the total saving of 1.64 per cent in New York, amounting to 0.82 per cent, is a saving to the New York property owner who carries insurance which results from better water-supply services. With 6 billion dollars of property insured in New York, this gives a savings of 49.2 million dollars. For a population of 9 million people; this represents $5.50 per capita which can be compared with $1 per capita as the approximate costs of the waterworks fire-protection services.[1]

Fire services place a definite obligation upon the water-supply utility. The waterworks operators feel, since the fire-fighting capacity of their system is always limited, and at best can be only a fighting device and not a preventive, that they should be

[1] Barker, Harry, "Public Utilities Rates," p. 257, McGraw-Hill Book Company, Inc., New York, 1917.

held for reasonable and not unlimited demands.[1] But recent court decisions in Kentucky (*Paducah Lumber Co. v. Paducah Water Supply Co.*, 89 Ky. 34; 133 S.W. 249), North Carolina, and Florida have held that water-supply companies which had failed to furnish an adequate quantity of water for extinguishing fires were subject to damages for the fire losses. The decisions in these cases hinged upon the failure of the company to fulfill its contractual obligations. It happens that many of the contracts (or franchises) between water companies and the municipalities are stated in very general terms such as "the company shall furnish all the pure water that may be required or demanded at any time and all times for public and private purposes and for fire protection." Under such broad terms, it is not difficult to prove that a company has failed to fulfill its contract, and this regardless of the quantity of water it may have supplied. Since the service is a fire-fighting and not a fire-preventing activity, the company should be required to furnish reasonable fire-fighting facilities only. Its obligation in this respect should be clearly established by defining reasonable standards for adequacy of mains, the number and distribution of dead ends, the frequency and distribution of cross connections between mains, the quantities of water to be supplied, and the location and spacing of hydrants.[2]

Water Utility Rates.—The principal and ordinarily the only source of revenue for the water-supply system is derived from the sale of water. It is necessary therefore that rate structures be designed to reflect the conditions of supply and demand in each given case. In so far as supply is concerned, generalization is difficult since water is supplied under many different conditions. The source of the water supply, the treatment for purification purposes and for taste and odor removal, the elimination of hardness, the amount of pumping required, and the size and nature of the distribution system will differ materially from one system to another. In some cases, conditions of supply exhibit characteristics of decreasing costs while in others increasing costs are incurred. The former condition holds true for

[1] GOLDON, R. G., and P. HANSEN, Responsibility of Water Companies for Fire Protection, *Journal of the American Water Works Association*, vol. 21, pp. 1291 *ff.*, October, 1929.

[2] *Ibid.*

those systems which draw their water from large near-by lakes or rivers and the latter condition for those systems which encounter enormous expenses in developing new sources of supply, as did New York in its Catskill watershed. The level of the rates will largely be determined by the conditions of supply, and the type of rate structure used must reflect the conditions of cost encountered by particular systems.

Demand for water service usually comes from four classes of customers: domestic; industrial; municipal, for street flushing, sewage disposal, public buildings, fountains, parks, swimming pools, etc.; and fire protection. The first three of these groups are frequently classified under a single heading called "General Service," but, on the basis of the nature of the use and the differences in quantities used, the narrower classification into four groups seems to be more satisfactory. The demand of the domestic consumers is fairly constant throughout the day, declining sharply only during the late night and early morning hours, and seasonal variations in domestic services are not extreme. Some industrial consumers make use of water supply in reasonably constant amounts; others have irregular use; and some supply themselves from a private source but are connected to the public supply in case of a breakdown. The municipal or public demand is of several types: water for use in public buildings, street cleaning, and the like is consumed in reasonably constant amounts; demand for water for fountains, parks, and swimming-pool uses is largely seasonal in nature. The fire-protection demand is largely a stand-by demand, requiring plant and equipment capacities which are seldom used.

It is the combined maximum demand of these various classes of consumers which determines the size of the system. Capacity must be installed to supply these demands, and so, as in the case of manufactured gas, each user or class of users should pay for the fixed costs arising from the investment in plant and equipment made necessary in order that they may be supplied. However, it has been the general practice on the part of water-supply utilities to construct plant capacities in excess of actual needs and to enlarge those capacities prior to the time when maximum demands and capacity are equal. Allowance for future growth is one reason for these practices; another reason is that frequently when a watershed is tapped and reservoirs

constructed it is desirable to drain a larger area and construct larger reservoirs than immediate demands require. In cases where plant capacity is much greater than present needs, the influence of the peak load is not so significant as it is in the case of gas and electric utilities. On the other hand, it is not to be denied that the theoretically desirable rate is that rate which assesses costs against the users in proportion to their responsibility for those costs. Thus, the rate structure should assess the fixed costs of production capacity against the users or class of users responsible, and the only basis for such an assessment is the relationship of the demand of the consumer (or class of consumers) to total demand on the system. At the same time, the rate schedule could be designed on such a basis that it would promote the usage of water, thereby giving to the company the benefit of decreasing costs as more complete utilization of the existing plant takes place. This benefit arises from the fact that increases in operating costs do not increase in proportion to the increase in quantity of output and to the fact that with a larger output, there are more service units over which the fixed costs can be distributed.

Charges for water supply are among the least scientific of the charges made for public utility services in the United States. The fact that many services are unmetered makes it impossible to relate rates even to the quantity of water used. Certainly there can be no scientific cost allocation to customers in such a case. Even where meter rates are employed, there has been but little development of rate schedules embodying the principle of a demand charge. The industry seems, however, to be becoming rate conscious and there has been a noticeable tendency toward metering and the installation of meter rates which recognize the principle of decreasing the rate per unit as consumption increases. There is, too, a growing recognition that each customer is responsible for some of the fixed costs on the business and the use of minimum charges or service charges, covering at least customer costs, is now more general than in the past.[1]

Before the use of meters, and still practiced in unmetered services, flat rates were used. Such a rate may be purely an

[1] See *American City*, vol. XLIX, May–December, 1934 and vol. L, January–December, 1935, for examples of rate schedules now being used.

arbitrary amount but more usually the amount of the charge is based upon the number and type of fixtures used, the value of the property served, street frontage of the property, rental value of the property, number of rooms in the building, or the size of the tap from the distribution main. It can easily be seen that flat rates, even when related to some stated base, need bear no relationship to the actual quantities of water used. They therefore produce many discriminations between customers and, on the whole, are inequitable. It is now generally believed throughout the industry that flat rates are an abomination, particularly since they provide for no check whatever on the quantities of water used and wasted. The flat-rate system of charging is retained in many localities because of the initial expense attached to meter installation. The validity of this reason is open to question since some authorities believe that "while the cost of operating a meter system may be as great as one without meters, it will usually be found that through the use of meters capital investments are reduced and water services improved."[1]

The system of flat rates is being superseded by a system of meter rates. Meter rates employed in the industry are of several types:[2]

1. Uniform rates, flat meter rates, or straight-line meter rates. These are rates in which the cost of water, either per gallon or per cubic foot (both units being extensively used as the unit of measurement for the quantities of water delivered through a meter), remains the same regardless of the quantity of water used. Such rates are being used to a considerable extent.

2. Uniform rates with a minimum or service charge. A minimum rate is an amount collected, no matter how small the consumption of water may be, for a specified period, monthly, quarterly, etc. Any water used in excess of a specified minimum allowance is charged at a uniform rate per gallon or per cubic foot as in the case of the flat meter rates. The minimum charge

[1] Fenkell, G. H., The Management of Water Works Business, *Journal of the American Water Works Association*, vol. 20, p. 311, Sept., 1928.

[2] Unless otherwise noted, this discussion of meter rates is based upon "Municipal Index," 1924, pp. 313 *ff*. Allen Hazen, "Meter Rates for Water Works," published in 1917, contains much good material even though it is largely out of date. See also "Manual of Water Works Practice," pp. 460 *ff*.

entitles the user to a specified quantity of water during a specified period of time. The minimum-rate type of schedule is now used in the majority of American cities. It may be used in connection not only with uniform rates but also with any form of sliding-scale or step rates.

A service charge is a charge made for the privilege of enjoying the service and is made in addition to a charge for the water used. It is in this respect that it differs from the minimum charge. The amount of the service charge is usually apportioned or determined by the size of the meter or service connection. In this way it can easily be adapted to use for the stand-by demands of industries and fire-protection services. Like the minimum charge, the service charge assesses against each customer a charge which is theoretically representative of that customer's share of responsibility for investment in plant facilities. Unlike the minimum charge it does not include any charge to cover operation and maintenance expenses, but since all water used is charged for, the rate for the water is designed to cover these costs. One of the chief criticisms of the service charge is that on sanitary grounds every customer should be required to pay for a certain amount of water in order that there be no incentive to consume less water than is needed to conserve health. On the other hand, the advocates of the service charge contend that experience of cities where there is no minimum charge demonstrates that a minimum charge is not required for sanitary purposes. It is also claimed that enforcement or development of sanitary conditions is a matter for the health department rather than for the water department or company.[1]

Opposition to the service charge has also been voiced on grounds that it leads to higher rates. The fallacy in this claim is apparent. If the revenues of the water company are adequate to cover the costs of the service and yield a fair return on the capital invested, the introduction of a service charge changes merely the assessment of costs against the consumers. Total revenues need not be increased but if they should be so increased, the service charge should be accompanied by lower rates for the water consumed. The service charge, then, is merely a means of distributing the costs of supplying the water among the

[1] JONES, ELIOT, and T. C. BIGHAM, "Principles of Public Utilities," pp. 357–358, The Macmillan Company, New York, 1931.

consumers; some customers will pay more and others will pay less, but the total payments of all customers should not be increased by the use of a service charge.[1]

There is some question as to what should be included in the service charge. If the service charge is small, it will cover approximately the cost of reading and maintaining meters and the probable value of the water which passes through the meter unrecorded. Where the service charge is higher and related to the size of the meter or service connection, it embodies some of the characteristics of a demand charge. For domestic customers and other classes of customers without sharp peak requirements, the service charge should probably be no higher than an amount to cover the customer costs. In the case of industrial stand-by and fire-service demands, where actually but little water may be consumed, but where at times of usage sharp peak loads are likely to result, a high service charge covering demand costs should be assessed.

Either a minimum charge or a service charge payable by each customer connected to the distribution system, regardless of whether any water is used or not, can be justified on grounds that every service connection represents a certain part of the total investment cost of the system and accordingly should bear its share of maintenance and operation costs. Any consumer using less than the minimum volume fixed, if assessed on any other basis, may not return a revenue sufficient to pay for the maintenance of that service, so that its provision is at an actual loss and becomes an added charge on the consumers who use more water.

3. Graduated minimum rates. In this form of rate, the minimum charge is based upon the size of the meter or service connection and increases with an increase in the size of the meter. In Philadelphia, for instance, the minimum charge for a ½-in. meter is $8, for which 8,000 cu. ft. of water are allowed. The ⅝-in. meter, the usual domestic size, has a minimum charge of $12, with 12,000 cu. ft. of water allowed. This increases up to $1,150 for larger sized meters, with a maximum allowance of 1,150,000 cu. ft. of water. All water in excess of the allowed quantities is billed at a uniform rate of 40 cents per 1,000 cu. ft. The theory underlying the graduated minimum charge is that it

[1] *Op. cit.*

apportions more equitably than an ungraduated minimum the share of investment, operating, and maintenance costs of the plant which each customer should bear. It is somewhat similar to the service charge in this respect. The graduated minimum charge can best be used where there is a large number of industrial customers.

4. Sliding-scale or block rates. This type of rate includes those cases where a rate is charged which varies with the quantity of water used. It may be used with or without a minimum or service charge. A block-scale plan, used in conjunction with a minimum charge, is used in the majority of water systems in the United States. A block-rate schedule provides that the water used, up to a specified amount, is charged at a certain rate and additional quantities are charged at lower rates, but the higher charge on the first quantity remains a part of the charge to the customer.

5. The step-rate or jump scale. This type of rate schedule provides that a specified quantity of water is charged at a certain rate; beyond that limit and inside another limit, a lower price per unit of consumption is named. This differs from the block rate in that the lower price applies to all water consumed. There can be as many steps as the individual company sees fit to use. The weaknesses of the step rate have previously been indicated.[1]

The New England Water Works Association in 1916 approved a standard form of block rates for use by water utilities. This was later modified and approved by the American Water Works Association. Because of the fact that the majority of the users of public water supplies are domestic customers and about 90 per cent of these use the same size meter, it is believed that a block rate with a service charge will approximately and satisfactorily cover the fixed costs incurred by the company to supply each of these customers. The service charge can be increased for other classes of customers and made to include a demand charge to cover the fixed costs required to serve these customers. It is for these reasons that the industry could agree in approving a standard form of rates.

The standard form as approved by the New England Water Works Association recommends three blocks, called domestic,

[1] P. 43.

intermediate, and manufacturing.[1] The sizes of the blocks are based upon the quantity of water consumed and not upon the use to which it is put, the contrary implications of the names notwithstanding. The American Water Works Association recommends the addition of a fourth block for unusually large consumption when desirable or necessary. The relationship between the blocks was recommended to be that the rate in the third block should be one-half the rate in the first block; the rate in the fourth block should be one-third the rate in the first block, and the rate in the second block should be an average of the rates in the first and fourth blocks.[2] Thus, if the rate in the first block is $1 per 1,000 cu. ft. (or gallons), the second will be 66 cents, the third 50 cents, and the fourth 33 cents. Obviously, the relationship of the rates specified in these blocks can be varied to meet local conditions, as can the quantities of water specified in each block. If the cost of obtaining the water is relatively high, the quantities for each block can be large and the spread in the rates between the blocks can be small. For situations where the cost of procuring the water is relatively low, the quantities for each block can be small, thus more rapidly reaching the last block with its lower rates, and the spread in the rates between the blocks can be large. It was also recommended that these blocks be accompanied by service charges which should be related to the size of the meters and in ratio or relationship to meter capacity. Demand costs, it is believed, could be satisfactorily covered by the service charge.

It should be pointed out that none of these rate schedules, except possibly where there is included a very high service charge, are satisfactory for determining the charges for the fire-protection service. The most common basis for assessing fire charges is a hydrant rental. This is a satisfactory basis only if the amount of the rental per hydrant is obtained by determining the cost properly to be borne by the fire service and dividing that amount by the number of hydrants. Hydrant rental is usually, however, merely an arbitrary figure, frequently

[1] *Journal of the New England Water Works Association*, vol. 30, pp. 316–411, 453–478, 1916.

[2] *Journal of the American Water Works Association*, vol. 10, pp. 871–881, 1923; and "Manual of Water Works Practice," pp. 460 *ff.*

being the average of the hydrant rentals in near-by towns which in turn are arbitrary figures.

An improvement over the hydrant-rental basis of charges is the making of charges on the basis of the number of miles of pipe included in the distribution mains, with an allowance per hydrant for maintenance. This basis roughly apportions the charges to the capacity of the system. Since all mains in the system will not be of the same size, the per-mile basis of charging does not directly relate charges to capacity. This can be more closely accomplished by assessing the charges for fire service on the basis of inch feet of pipe (linear feet of pipe times diameter in inches) in the distribution system, with an allowance per hydrant for maintenance. Fire service can also be charged a proportion of annual cost, with a fixed sum per hydrant for maintenance and depreciation. This method involves making a cost allocation and charging the fire service its proportion of the annual costs of doing business.[1]

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[1] DOBBIN, R. L., Charges for Public Fire Protection, *Journal of the American Water Works Association*, vol. 17, pp. 647 *ff*.

CHAPTER VI

MOTOR TRANSPORTATION AS A PUBLIC UTILITY

Much of the confusion and controversy with respect to highway and motor transportation is due to the consideration of the industry as a homogeneous structure rather than as a number of very different although related industries, as it should be considered. It is true that the broad function of highway and motor vehicular transportation is to transport passengers and goods from place to place by means of automotive vehicles operated over streets or roads, but the performance of this function is achieved by many different organizations and not by one industry. The industry as a whole employs directly and indirectly 10 per cent of the total number of persons "gainfully employed" in the United States.

The Manufacturing Industry.—In the first place there is the automotive vehicular manufacturing industry, which includes the providers of raw materials, automotive vehicles and accessories necessary and incident to the production and distribution of automobiles, motorbuses, motor trucks and trailers, and other road-transport vehicles and equipment. This industry or group of related industries is one of the most important in the United States as well as in the world. The automotive industry, despite the decreases in productive activity in the desperate years following 1929, is the largest user of a number of basic raw materials or semifinished articles, including gasoline, lubricating oil, rubber, malleable iron, plate glass, nickel, lead, upholstery, leather, and mohair.

The National Automobile Chamber of Commerce, the nationwide trade association of the industry, reports that in 1934 the automotive industry used the following percentages of the total output of the industries shown below:

	Percentage
Gasoline	89
Rubber	75
Lubricants	59

	Percentage
Cotton fabric	9.1
Plate glass	70
Nickel	30
Aluminum	15
Iron	57
Steel	25
Lumber, hardwood	8
Copper	18
Lead	38.8

In 1934, automotive manufacturing and highway construction resulted in the shipment by railroad of 3,064,805 carloads of freight traffic, according to estimates made by the National Automobile Chamber of Commerce. In 1933, the same industries shipped 2,621,000 carloads by railroad. The traffic in 1934 was:

	Carloads
Motor vehicles, parts, and tires	472,505
Gasoline	1,140,000
Iron and steel	153,000
Coal	51,000
Crude petroleum	49,000
Lubricating oil	73,000
Lumber	23,000
Road and fuel oil	41,500
Crude rubber	9,800
Asphalt	54,000
Vitrified brick	45,000
Cement for roads and bridges	222,000
Gravel, sand, and stone for roads	620,000
Miscellaneous freight including nonferrous metals, paints, and upholstery materials	111,000
Total, 1934	3,064,805

In 1934, the automotive-vehicle industry produced in the United States and Canada 2,869,963 vehicles, including 2,270,566 passenger automobiles and 599,397 motor trucks. The total wholesale value of passenger automobiles in 1934 was $1,204,-376,351, an average of $530 per automobile, and that of the motor trucks was $332,913,985, an average wholesale price per truck of $555. The industry was responsible also for the production of parts and accessories for replacements and service equipment with a wholesale value of $752,497,000, and tires for

replacement with a value of $317,894,000. The total value of vehicles and service equipment, accessories, and replacements of parts and tires aggregated $2,493,198,716 in 1934. In the same year the retail value of gasoline consumed, including gasoline taxes, amounted to $3,126,531,912. The production of automobiles and trucks increased rapidly in number and value from 1895, when 4 vehicles were produced, to 1929, when 5,621,715 automobiles and trucks were manufactured, with only occasional setbacks in 1918 and 1919, during and after the World War period, in 1921, a year of decreased activity following the World War, in 1924, and in 1927. After 1929, production of automotive vehicles declined greatly from the total of 5,621,715 automobiles and motor trucks in 1929 to 3,510,178 in 1930, to 2,472,359 in 1931, and to 1,431,494 in 1932. The production of 2,048,000 automobiles and motor trucks in 1933, and 2,869,963 in 1934, broke this precipitous drop in production. The wholesale value of automotive vehicles, after increasing from less than $5,000,000 in 1900, to $3,576,645,881 in 1929, fell to $2,126,602,019 in 1930, to $1,426,656,252 in 1931, and to $793,045,300 in 1932. The aggregate wholesale value of vehicles produced in 1933 rose to $970,200,000, and to $1,537,290,336, in 1934, but was still below the peak in 1929.

The total motor-vehicle registration climbed steadily without a single setback from 4 vehicles in 1895 to 23,121,589 passenger cars and 3,379,854 motor trucks, or 26,501,443 vehicles in 1929. In 1930, the registration of passenger motorcars declined to 23,059,262, a decline of 0.3 per cent, but the motor trucks registered increased 3 per cent to 3,486,019 vehicles, and this was sufficient to produce a slight increase in the number of all motor vehicles to 26,545,281, an increase of 0.16 per cent. In 1931, passenger-car registration fell 3 per cent to 22,366,313; truck registration declined 0.6 per cent to 3,466,571; and the total automotive vehicles registered decreased 2.5 per cent as compared with the preceding year to 25,832,884 vehicles. In 1932, passenger-automobile registration fell 6.5 per cent to 20,903,422; truck registration decreased 6.7 per cent to 3,233,457; and the total automotive vehicular registration declined 6.6 per cent to 24,136,879. The decrease in registration was not checked by the increased production of automobiles and motor trucks in 1933, but in 1934 passenger-automobile registration

rose to 21,524,068, and truck registration to 3,409,335, a total registration of 24,933,403.

Private Automobile Transportation.—The figures for automobile and truck registration do not include tax-exempt official cars of the United States, state, and local governments. In 1934, there were 36,475 United States government official cars and 193,211 state and local government cars, or a total of 229,686 vehicles excluded from registration figures for this reason. The rise of the passenger-automobile industry to a position of one of the outstanding industries of the world and an important part in the industrial and social structure of the United States, and the development of the automobile as an indispensable means of transportation for millions of families,

TABLE 16.—PASSENGER-AUTOMOBILE REGISTRATION IN THE UNITED STATES, 1895–1934

Year	Total registration	Year	Total registration
1895	4	1915	2,309,666
1896	16	1916	3,297,996
1897	90	1917	4,657,340
1898	800	1918	5,261,617
1899	3,200	1919	6,771,074
1900	8,000	1920	8,225,859
1901	14,800	1921	9,346,195
1902	23,000	1922	10,862,650
1903	32,920	1923	13,479,608
1904	54,590	1924	15,460,649
1905	77,400	1925	17,496,420
1906	105,900	1926	19,237,171
1907	140,300	1927	20,219,224
1908	194,400	1928	21,379,125
1909	305,950	1929	23,121,589
1910	458,500	1930	23,059,262
1911	619,500	1931	22,366,313
1912	902,600	1932	20,885,814
1913	1,194,262	1933	20,616,234
1914	1,625,739	1934	21,524,068

have been a development of the past quarter century. The registration of passenger automobiles in the United States from the first year in which registrations were recorded, 1895, until 1934 is shown in Table 16. The registration figures are

those of December 31 of each year as reported by the National Automobile Chamber of Commerce.[1]

The serviceability of private automobiles to the public is indicated by the almost incredible increase in the number of miles of passenger transportation performed by automobiles, from less than 40,000,000,000 passenger miles in 1917, to over 400,000,000,000 in 1930. The depression has reduced this enormous mileage somewhat since 1930, but it is still well over 360,000,000,000 passenger miles. A comparison of passenger

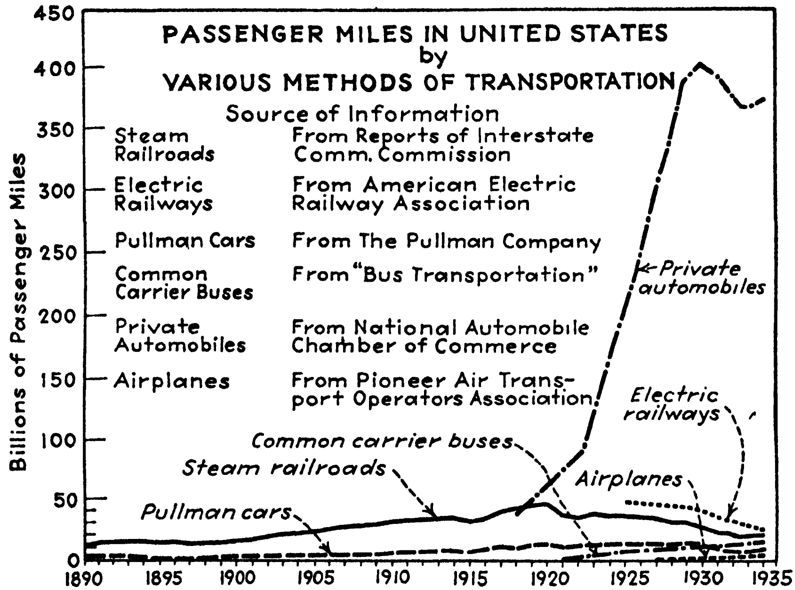

FIG. 4.

miles in the United States by various means of transportation is shown in Fig. 4.

The sensational increase in private-automobile transportation has revolutionized urban and rural life. It has made possible the broadening of the lives of rural and small-town residents by breaking the shackles of farm and village life in placing improved education, the theater, churches, hospitals and better medical facilities, libraries, museums, and other social institutions within easy reach of many rural residents. In like manner

[1] National Automobile Chamber of Commerce, "Facts and Figures of the Automobile Industry," New York (annual).

the automobile has made it possible for city people to travel throughout the country, to visit farms and villages, and to see the natural beauties of the United States, Canada and Mexico, at first hand. The automobile has done much to reduce provincialism and to break down the barriers between rural and urban dwellers.

The rapid development of the motor-vehicle industry has been accompanied by the spectacular development of improved highways. It cannot be said that the motor vehicle caused the development of improved highways, nor that improvements on highways caused the development of the motor industry. The two worked in reciprocal relationship to produce a cumulative effect upon both. The present highway system of the United States consists of 3,009,066 miles of highway usable for motor transportation. The system consists of 2,663,315 miles of local or country roads and 345,751 miles of state highways. There are approximately 868,000 miles of surfaced rural roads, 600,000 miles of which are local roads, and 268,000 miles are state highways. About 150,000 miles of highway are of the "high-type" surface construction.

The tendency in highway construction has been to build and construct highways of wider and higher surfaced types. In 1932, about 55,000 miles were surfaced or reconstructed. About $1,250,000,000 was expended on rural roads and approximately $400,000,000 on city streets. The Federal Aid Highway system in the fiscal year of 1932 included 200,013 miles of approved roads, of which 101,032 miles had been completed with Federal aid. Nearly 16,000 miles of road were constructed or reconstructed with Federal aid in this period. Federal highway-aid appropriations are now being made at the rate of about $124,-000,000 per annum.

The Motor-truck Industry and Freight Transportation.—Another fundamental division of the motor industry and highway transportation includes the manufacture and distribution of motor trucks and the use of these vehicles in the transportation of freight by private owners and operators and by carriers for hire. Statistics of the production and wholesale value of motor trucks are not available for years prior to 1904, because the negligible number of freight vehicles produced prior to that year were included with the passenger-automobile production figures.

The data presented in Table 17 show the number of motor trucks produced and the value of the chassis without bodies. The figures from 1921 to the present include with the United

TABLE 17.—MOTOR TRUCKS PRODUCED ANNUALLY AND MOTOR TRUCKS REGISTERED IN THE UNITED STATES

Year	Number of trucks produced	Wholesale value	Number of trucks registered
1904	411	$ 946,947	410
1905	450	970,000	600
1906	500	1,050,000	1,100
1907	700	1,360,000	1,700
1908	1,500	2,550,000	3,100
1909	3,255	5,230,023	6,050
1910	6,000	9,660,000	10,000
1911	10,681	21,000,000	20,000
1912	22,000	43,000,000	41,400
1913	23,500	44,000,000	63,800
1914	25,375	45,098,464	85,600
1915	74,000	125,800,000	136,000
1916	92,130	161,000,000	215,000
1917	128,157	220,982,668	326,000
1918	227,250	434,168,992	525,000
1919	275,943	423,326,621	794,372
1920	321,789	423,249,410	1,006,082
1921	164,304	169,914,098	1,118,520
1922	277,140	231,282,063	1,375,725
1923	426,505	317,478,940	1,612,569
1924	434,140	326,706,496	2,133,028
1925	557,056	470,634,763	2,441,709
1926	556,818	468,752,769	2,764,222
1927	497,020	435,072,641	2,914,019
1928	588,983	459,045,380	3,133,999
1929	826,817	595,504,039	3,379,854
1930	599,991	405,949,915	3,486,019
1931	434,176	272,748,305	3,466,571
1932	245,285	142,264,003	3,229,315
1933	358,548	192,131,509	3,227,357
1934	599,397	332,913,985	3,409,335

Source: National Automobile Chamber of Commerce, "Facts and Figures of the Automobile Industry," New York (Annual).

States production the number and value of trucks produced in Canada. These statistics show that the number of motor trucks registered in the United States grew steadily but not spectacularly from 1904 to 1914. The great impetus given to

motor freight transportation by the demand for speedy and flexible freight transportation in the World War and post-war periods accounts for the spectacular annual increase in the numbers of trucks registered in the United States between 1915 and 1929. A slight increase in registration was recorded in 1930 but there were decreases in 1931, 1932, and 1933 as a result of the depression. In 1934, however, there was an upswing, registrations increasing about 180,000.

Motor trucks are used in many different services: in manufacturing; in the extraction of raw materials, including coal and ores, forest products and petroleum; in agriculture; and in wholesale and retail distribution of many kinds. More than 5,000,000 motor vehicles, including over 900,000 motor trucks, or nearly 27 per cent of the total number of trucks registered, are used on farms. In addition, over 920,000 tractors are engaged in service on farms. A survey conducted recently by the National Automobile Chamber of Commerce covered 126 business establishments which operate fleets of 100 or more trucks each. The largest operator of motor trucks is the American Telephone and Telegraph Company with 12,970 trucks; next is the Standard Oil Company of New Jersey with a fleet of 12,000 trucks; and the third largest operator is the Railway Express Agency, Inc., which operates a fleet of 8,454 motor freight vehicles. Forty-seven companies have fleets of more than 1,000 trucks; and 32 have fleets between 500 and 1,000 trucks. These companies include public service companies, dairy-products distributors, petroleum refiners and distributors, bakery-products companies, grocery and other food distributors, ice companies, packers, tea and coffee distributors, ice-cream producers and distributors, municipalities, tire and rubber manufacturers, and state highway departments. Four motor-freight-transportation companies are included in this survey: the Railway Express Agency, Inc., with a fleet of 8,454 motor trucks; the United States Trucking Company, with 1,200 trucks; the United Parcel Service, operating 1,200 trucks and the Motor Haulage Company, with a fleet of 159 motor freight vehicles.

Types of Carriers.—There is great difference of opinion as to the distribution of motor trucks among the various types of highway users or operators. A recent survey conducted by the

Bureau of Public Roads of the United States Department of Agriculture in eleven western states estimated the distribution of the motor trucks to be as follows: privately owned and operated, 85.80 per cent; contract carriers, 8.70 per cent; and common carriers, 5.50 per cent. Whether or not these figures be accepted as typical of the distribution of motor trucks in the United States as a whole, there is no doubt that the overwhelming majority of motor trucks are owned and operated by the same individuals or companies that own the goods carried in the vehicles.

A smaller, but still a substantial, percentage of the motor trucks are owned and operated by contract carriers. Contract carriers, or private contract carriers as the courts have more recently distinguished them, are carriers engaged in the transportation of goods owned by others than the carriers for hire, upon the basis of contracts entered into by the carriers and their patrons for the transportation and delivery of the goods by highway-transport vehicles. Common carriers by highway, on the other hand, are those who hold themselves out to transport goods by highway vehicles for hire within the limits of their facilities for all who are willing and offer to pay the carriers' reasonable charges, without discrimination among their patrons.

Although there is little difficulty in distinguishing legally between clear cases of contract and common carriage in the field of motor freight transportation, there is great practical difficulty in determining the status of given truckers. Laws have been enacted by various state legislatures limiting the number of shippers and consignees that can be served by a single contract carrier, and classifying the truckers who haul for a greater number of patrons to be common carriers.

Motor trucks have greatly improved the speed, flexibility, and convenience of many types of freight-transportation services, and have intensified the competition among the various instrumentalities of transportation. Competition in the motor-freight-transportation field has increased so greatly in recent years that in many instances rates have been reduced below remunerative levels. This intense and often destructive competition has led to increasingly stringent regulation by the states and to the regulation of interstate transportation by the Federal government. There is much difference of opinion among experts within and without the motor-freight-transportation business

with respect to the desirability of regulation. A number of students of the question have opposed any type of regulation as an unwarranted invasion of the rights of business and as a device for restricting the normal development of highway transportation primarily in the interest of protecting artificially the interests of the small carriers. It has been urged that the motor-freight-transportation business is a newcomer to the field of transportation and that regulation should not be undertaken until after the industry shall have more nearly found its proper place in the transportation system of the United States. It also has been urged that the regulation of the business practices of common and contract carriers will place the regulated carriers at a comparative disadvantage as compared with the unregulated truckers and with the owners and operators of private trucks.

At the opposite pole of opinion in this controversial matter are those who have advocated comprehensive state and Federal regulation of intrastate and interstate motor freight transportation. Such regulation has been advocated on the ground that the interests of the motor-transportation industry will best be promoted by the regulation of the business so as to protect the legitimate truckers from excessive, unethical, and destructive competition. It has been argued that fair and constructive regulation will protect the better elements from the worse; and that it will stabilize the industry and thereby promote its development along economic lines. Many hold that all forms of transportation as agencies of commerce should be subject to state and Federal regulation, since it is the transportation of the goods as commercial intercourse that is the proper subject matter of governmental regulation, rather than the various types of carriers themselves, and regulation should be imposed in the public interest. However the question of regulation is approached, it must be conceded that the transportation of goods by motor trucks is, under certain conditions, an improved means of transportation which should not be positively regulated or taxed for the benefit of any other type of carrier, nor in such ways as to impair the economic development of the industry. Regulation should be undertaken from the standpoint of the paramount public interest, and with the protection of the economic interests of the general public and of all types of carriers as the ideals. It remains to be seen what effects regulation

by the Interstate Commerce Commission will have upon the industry but the effects should be great.

Types of Motor Freight Services.—The great variety of transportation services rendered by motor freight carriers can be conveniently divided into several types. The first type includes the purely local services performed within local terminal areas or in the rural districts, which can be called local cartage services. These services include the truckage of goods between railroad stations, steamship piers, and other depots and the places of business of shippers and consignees; the interchange of freight between different transportation companies' depots; the concentration and distribution services between the stations of the same carriers; and local cartage between the places of business of producers, manufacturers, wholesale and retail dealers, and consumers.

A second type of motor freight service closely associated with local cartage is the service provided by local express or motor-transportation companies which serve a city or town and its environs, the suburbs or smaller communities within a metropolitan area. In many cases the same motor-transportation companies offer both local cartage and city-suburban services of the latter type, but in other cases different companies offer these types of services. Most of the truckers engaged in the city-suburban service operate over irregular routes within the districts served.

A third type of motor freight service is the short-haul motor freight service over more or less definite routes between near-by cities and towns. It is not desirable to place an exact mileage limitation upon the type of service included within the term "short-haul service," because varying conditions of topography, highway surfaces, traffic conditions, climatic factors, and other considerations tend to expand or contract the areas considered to be within the short-haul field. In general it may be said to be the distance within which overnight freight service can be rendered regularly, and deliveries of goods forwarded at the close of the business day in one city can be made in the forenoon of the next day.

A fourth type of motor freight service is long-haul freight service between points beyond distances within which freight can be transported between the close of business one day and

the forenoon of the next. In some cases, freight carriers offer services on more or less regular time schedules, and over more or less regular routes between cities and towns many hundred or a thousand miles or more apart. Some of these long-haul services are offered to the public as common-carrier services, generally over irregular routes, while in other cases, the service is restricted to a limited number of patrons as contract-carrier service.

A fifth type of service rendered by motor freight carriers includes the services of transporting special types of traffic such as furniture and household goods, milk, machinery, petroleum products, forest products, coal, sand, gravel, cement, and other commodities. Some of the vehicles used in the transportation of these goods are specialized types of vehicles such as tank trucks, refrigerated or ventilated trucks, dump trucks, or other specialized vehicles, while in other cases the ordinary types of motor freight trucks are used. Sometimes the services are common-carrier services, whether over fixed routes between fixed termini or over irregular routes; while in other cases the services are contract-carrier services rendered only to patrons who contract with the carriers for their services. Special types of motor freight services include services performed by motor carriers operating through motor-freight agencies, clearing-houses, or exchanges; the services rendered by motor carriers who transport freight contracted for or solicited by independent motor-freight agencies or brokers; and the services operated by farmers' cooperatives or marketing exchanges of various types.

Relations between Carriers.—Motor freight services rendered by those who devote their vehicles to the service of others for hire may be rendered under any one of several types of arrangements with other carriers. A large number, how large no one knows with certainty, are operated independently of any other carriers. In some cases joint rates and through routes and billing arrangements are entered into with other motor freight carriers, but there are many examples of motor freight carriers which are engaged in the independent transportation of goods solely over their own routes. These carriers may be classified as independent motor freight carriers.

A second form of arrangement is found in cases where motor freight carriers enter into joint-trade and through-service arrange-

ments by means of joint tariffs, interchange agreements, and through-billing arrangements with other types of carriers, including railways and steamship lines. Through-rate and through-route arrangements between railroads and motor freight lines in the United States have been restricted in the past because of the policy of the Interstate Commerce Commission in refusing to permit joint-rate and through-service arrangements between carriers subject to the Interstate Commerce Act and those not within its jurisdiction.

A third type of arrangement includes agency contracts under the terms of which motor-transport companies act as the contract agents of other types of transportation companies in performing certain services which can be performed more satisfactorily or efficiently by the motor truck than by other means of transportation. Arrangements for the performance of store-door collection and delivery services, interstation concentration and distribution services, intercarrier interchange services, motor services as a substitute for trap or ferry-car services, and motor-truck services between railhead or pierhead depots and "off-track" or "inland" stations, are often made by motor-transportation companies as agents for other carriers.

A fourth type of arrangement for the performance of freight services by motor trucks is the operation of the vehicles by motor-transportation companies in which other types of transportation carriers have a financial interest through the ownership of the securities of the motor carriers. In some cases this interest may amount to a majority or controlling interest, while in other cases it may be substantially less than control. Other types of transportation companies sometimes have wholly owned subsidiaries, companies organized and managed by the parent company through the subsidiary corporation to render motor-transportation services to improve, extend, supplement, or replace the services performed by the parent company. A special type of arrangement for the performance of motor-freight-transportation services in connection with other types of transportation carriers includes the services of the car-consolidating or freight-forwarding companies. These companies operate motor trucks or contract with motor-truck companies to perform terminal collection and delivery or line-haul services, and arrange with railroads or steamship lines for line-haul services in

connection with carload lots of less-than-carload shipments from numerous shippers to a number of consignees. Also, arrangements are made in a few cases where express or forwarding companies contract with railroads, steamship lines, and motor freight carriers to perform certain parts of through-freight services offered the public by express or forwarding companies which neither own nor operate any equipment of any kind.

Business Organization.—It is impossible in a summary discussion to treat of the organization, management, or business practices of motor freight carriers. The business organizations offering freight services range from one-man, one-truck enterprises, to the larger individual enterprises, partnerships, and corporations. The trend is from the smaller, simpler forms of organization to the larger corporate types of organization through growth, consolidation, and merger. The rising tide of regulation and the increased need for stability and precision in business practices are strongly impelling influences toward larger and more complex organization and toward more complete and uniform arrangements in billing, classification, rates, tariffs, claim procedure, packing requirements, accounts, insurance, reports and statistics, records, operation, maintenance, advertising, solicitation, and other practices.

The Motorbus.—The transportation of passengers by motorbuses, or motor stages or coaches, as they are variously called, has developed rapidly in recent years. Prior to the World War passenger cars were used as public or semipublic conveyances, or "jitneys" as they were commonly called because of the "jitney" or 5-cent fare. A few motor-truck chassis were equipped with passenger bodies to render a crude type of service for passengers. During and immediately after the World War the number of jitneys increased rapidly, and the improved motorbus with specially constructed body and chassis made its appearance as a public conveyance in urban, rural, and intercity services.

It is difficult to obtain accurate statistical data. For the years prior to 1925, few figures are available and those are of doubtful accuracy. The best available data are those collected from actual censuses conducted by "Bus Transportation," and those published by the National Association of Motor Bus Operators. The figures of "Bus Transportation" go back to

1625, but in the years prior to 1931, they admittedly represent only about 94 per cent of the total number of buses in service. Since that year improvements in the methods of taking the annual census have made it possible to present a more comprehensive and actual inventory of the number of buses in service. Such statistics as are available are presented in Table 18.

TABLE 18.—TOTAL MOTORBUS REGISTRATION IN THE UNITED STATES

Year	Buses
1925	53,202
1926	63,646
1927	69,082
1928	75,717
1929	81,247
1930	87,625
1931	93,407
1932	105,786
1933	101,747
1934	106,277

Source: Compiled from data published in *Bus Transportation*, Annual Review and Statistical Numbers.

The Uses of Motorbuses.—Motorbuses are used in a variety of services. Between 55,000 and 60,000 buses are used in the transportation of students to and from schools. These buses in some cases are owned and operated by cooperating groups of parents; in other instances, by individuals who collect a daily or weekly fare for their services. The school-bus route mileage is nearly 650,000 miles. Another type of service performed by motorbuses is the transportation of workers between their homes and places of employment. The buses are owned and operated by industrial companies or by individuals or companies performing the special service for compensation as a contract carrier. It is estimated that about 800 motorbuses are used in various types of industrial service.

Buses are also owned and operated by hotels as conveyances to transport passengers, either with or without fare, between railroad depots, steamship piers, airports and hotels. Approximately 500 motorbuses are owned and operated by hotel enterprises. It is estimated by the National Association of Motor Bus Operators that the hotel, industrial, and other miscellaneous motorbus route mileage mounted to 7,300 route miles in 1932. Several hundred motorbuses are owned and operated by sight-

seeing companies, for transporting persons in tours of places of interest in cities, national parks, and other places of scenic or historic interest. All of the school, industrial, hotel, and sight-seeing services in which the vehicles are engaged in private, contract, or a special type of carriage may be classified as special services.

A second group of operations in the field of motorbus transportation includes the common-carrier services which are performed by motorbus companies entirely independent of any other transportation company. These independent common-carrier motor-transport companies include those operating in urban services, city-suburban, or metropolitan services, short-distance intercity services, or interurban services between cities a thousand miles or more apart. It is possible to travel from the Atlantic to the Pacific Ocean, and from Canada to Mexico, by interconnected motorbus lines. As in the case of motor-freight-transportation service it is difficult, if not impossible, to draw a sharp line of demarcation between the types of services operated by independent common-carrier motorbus lines. The lines serving cities, and those serving cities and surrounding communities in metropolitan areas can be classified as urban and city-suburban carriers, respectively, while motorbus lines connecting near-by cities within distances that can be traveled by bus in, let us say, four hours can be classified as middle-distance carriers. The rural motorbus lines which operate over rural routes serving towns, villages, and farms may also be classified as middle-distance carriers. The long-distance motorbus lines connect cities in different sections of the country, hundreds or thousands of miles apart, although it is unusual for buses to be operated over routes more than a thousand miles long. In most cases passengers are transferred from one bus or route to another where distances exceed several hundred miles, but in some cases passengers are transported in the same buses between cities more than a thousand miles apart.

Approximately 4,585 motorbus operators operated 32,213 buses in common-carrier services at the end of 1932. These common-carrier buses were operated in this year over 336,499 miles of bus route. They performed 527,000,000 bus-miles of city service, and 1,270,000,000 bus-miles of intercity service, a total carrier bus mileage of 1,797,000,000 bus-miles. These

carriers transported approximately 1,736,000,000 passengers; 1,314,000,000 in city service, and 422,000,000 in intercity service. They earned gross revenues of $101,400,000 in city service, and $247,400,000 in intercity service, a total of $348,800,000 of gross revenue, upon an investment estimated at $318,500,000 in rolling stock, and $91,000,000 in terminals and garages, or a total investment of $409,500,000.

Motorbuses are extensively used by urban and interurban electric railways as supplementary or replacement facilities. These coordinated electric railway-motorbus services are common in suburban service, and in middle-distance and long-distance interurban or intercity services. The motorbuses serve as feeders or alternatives or as complete substitutes for electric railway cars and tracks formerly used to perform such services.

The steam railroads of the United States also use motorbuses, but not quite so extensively as the electric lines, due, in part at least, to the fact that the competition of the motorbus has not been felt so severely as in the electric railway field where the length of the routes and the distances traveled by passengers are shorter. However, steam railroads have made considerable progress in recent years in coordinating railroad and motorbus passenger-transportation services through direct ownership and operation, through subsidiary motor-transport companies, through agency arrangements, through financial arrangements, and through combination routes and tour services. At the beginning of 1934, there were some 60 steam railroads operating motorbus services.

The uses of motorbuses by steam and electric railways may be summarized under the following types of operation:

1. As complete substitutes for routes formerly served by railroad facilities;

2. As feeder routes, connecting the rail lines and strategic points with territories not served by rail facilities;

3. As connecting routes between nonconnected rail lines;

4. As facilities for extending the rail lines beyond the rail termini;

5. As facilities operating on alternating "headways" with rail equipment in "alternating" or "staggered" headway service;

6. As facilities operating over more or less parallel routes at distances from the rail lines to serve additional territory;

7. As cross-country short-cut lines, connecting several branches of rail lines;

8. As terminal facilities for the collection and delivery of passengers;

9. As supplementary facilities to perform local passenger service to relieve the express railroad trains or electric railway cars which serve only the major stations; and

10. As organized tour services.

The Taxicab.—No discussion of the field of motor transportation, however summary in character it may be, is complete without some reference to the taxicab and its place in public motor transportation. No data are available which show with any degree of accuracy the number of taxicabs in service in the United States, due to the relatively large turnover in the business and to the lack of consistent municipal and state regulation. The taxicab performs a useful and, in many cases, an indispensable urban passenger-transportation service, but the rapid increase in the number of taxicabs in many cities and towns has caused destructive rate cutting, in many cases to levels below the cost of supplying the services rendered. It has resulted in taxicab rate and service wars, in excessive increase in "cruising" for fares, in an increase of street-traffic congestion, and in a general demoralization of the industry. The revenues of many of the legitimate taxicab companies have been greatly reduced without corresponding decreases in operating costs although a somewhat more stable condition in the industry has been achieved in the cities where stronger companies or associations have been organized, and where the services and fares of the taxicab companies have been subjected to municipal or state regulation.

The taxicab business is in its very nature a public utility. The individuals or companies which render the service hold themselves out to serve the general public and to carry without discrimination all who are willing to pay their relatively uniform rates of fare. As common carriers for hire, they should be regulated in the public interest and to protect legitimate taxicab and other transportation utilities from destructive competition.

In "A Nationwide Survey of Taxicab Regulation" conducted in 1932 by the American Electric Railway Association (now the American Transit Association) it was found that:

> Taxicabs in many cities have increased in number far out of proportion to the reasonable demands for cab service. "Wild-catters" have forced all cab rates far below the actual cost of producing the service, until the difference between the taxi fare and the fares charged on the street railways and buses has practically disappeared. When this occurs the unregulated carrier operating on a financially unsound basis enters into direct price competition with the regulated street railway and the motorbus as well as with the responsible organized cab companies.
>
> No community in the country, except those in which the taxicab has been legally declared a public utility and regulated accordingly, can consider itself free from the imminent possibility of a taxicab rate "war" which may wreck or seriously injure its established transportation services, without being able to offer a satisfactory substitute. . . .[1]

The taxicab must be considered a legitimate and useful auxiliary transportation facility of public utility status and subject as such to regulation. The fares of such carriers should be determined not by rate wars which cripple all participants but by public authority after consideration of the fair costs of rendering the service and its value to the users.

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CHAPTER VII

URBAN TRANSPORTATION

Local transportation plays a significant and often unappreciated part in the development of urban communities. It is one of the principal factors affecting and contributing to the development of industrial, commercial, social, and political life in both large and small communities, particularly in the large centers of population. The increase in the population of large cities, the spreading of the population over surrounding territory, the development of industries inside and outside the cities, the growth of large wholesale and retail business districts, and industrial sections within and on the outskirts of the cities, and the growth and spread of suburban and semisuburban residential districts all have tended to produce a stupendous problem, or more accurately a series of problems, in urban mass transportation.

A number of different instrumentalities of transportation are used in supplying the need for the movement of persons to and from their homes, apartments, offices, workshops, shopping districts, and places of amusement; and it is a grave mistake to think of urban passenger-transportation problems solely in terms of the electric street railway. In addition to this important instrumentality of local transportation, the city and suburban branches of steam railroads and electrified railroads, subway and elevated railway systems, motorbuses, taxicabs, "jitney" buses, and private automobiles play important roles in modern urban and suburban transportation.

The Growth of American Cities.—The rapid concentration of population in the cities of the United States, and especially in cities of more than 100,000 population, during the last generation has given rise to many difficult transportation problems. In smaller cities and towns workers can and often do walk between their homes and places of employment, and the shoppers purchase their food, clothing, furniture, and other supplies at shops within walking distance of their residences. Pleasure seekers attend

places of amusement near by their homes, and no transportation problems are created. With the concentration of population in large metropolitan areas, including the larger cities and their adjacent suburban districts, there is a tendency to develop sections within the cities in which specialized activities are carried on. Thus, there tend to be created wholesale districts, industrial districts, retail trading districts, sometimes specialized as to the types of retail distribution, amusement districts, and residential and apartment-house districts. There is, moreover, a tendency toward migration of residences from the old in-city residential to the suburban zones. All of these changes tend to increase the length of haul, the number and complexity of street railway routes, the congestion of traffic, and the riding habit.

In 1800 there was no city in the United States exceeding 75,000 population, but at the present time there are 191 cities which have a population of 50,000 or over, the total population of these cities representing 34.7 per cent of the population of continental United States. More than half of the population of the United States lives in chartered municipalities having a population of 2,500 or more persons, where provision must be made for some sort of public transportation. As the size of the cities increases the need for and the complexity of local transportation tend to increase until the most intense need and greatest complexity are reached in the cities with populations from a quarter of a million to several million persons. In such cities the street railways transport over 75 per cent of the total local passenger traffic. The number of cities in the United States having populations of 50,000 or more, according to 1930 census figures, classified into five groups, are shown in Table 19.

TABLE 19.—NUMBER OF CITIES OF 50,000 POPULATION AND OVER IN THE UNITED STATES

	Number of Cities
Over 1,000,000 population	5
500,000 to 1,000,000	8
250,000 to 500,000	24
100,000 to 250,000	56
50,000 to 100,000	98
Total	191

In addition to these larger cities there are 185 cities in the United States having populations of 25,000 to 50,000. All of these 376 cities have, and must have, some form of public mass transportation. In the larger cities especially, the demand for mass-transportation facilities is imperative. It has been shown that approximately two-thirds of all the 29,000,000 people in cities of 250,000 and over are dependent upon public transportation for their daily travel to and from central business areas. Further evidence of this dependence is seen in the increase in the riding habit in large cities, as shown in Fig. 5.

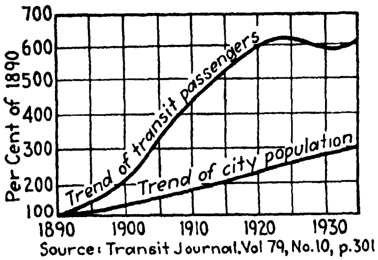

FIG. 5.—Trend of the city riding habit.

Urban Street Railway Transportation.—The principal agency engaged in mass transportation in the larger cities is the street railway industry. It is the direct lineal descendant of the horsecar companies which served a number of cities of the United States following the establishment of the horsecar service on Fourth Avenue, New York, in 1830. Tramways using stationary engines for power were in use in a few places prior to 1830, but their use was never general. The horsecar lines, serving one or several streets, soon demonstrated their superiority over the railless vehicles of the period in economy of operation and in comfort for the passengers. The horsecars were small omnibus-like vehicles drawn by one horse over flat iron strips laid over wooden stringers, and judged by modern standards they were seriously deficient in speed, comfort, ventilation, lighting, and heating, but they became increasingly popular. Improvements were made in track and vehicles as well as in service so that the horsecar industry was an important factor in local transportation in the period just prior to the Civil War.

In 1873 the cable car was introduced. It was first used on the steep hills in San Francisco where the grades on many of the streets were too steep for horsecar operation, and gradually the use of cable cars spread to other parts of San Francisco and attracted the attention of street railway operators and promoters in other cities of the United States. Between

1881 and 1890 cable-car lines were built in Philadelphia, New York, and Kansas City, Missouri. The cable cars, operating over the streets at from 8 to 11 miles per hour, were a great improvement over the horsecars, and by 1893, there were 658 miles of cable-car lines in operation in the larger cities of the United States.

Prior to the advent of the electric streetcar, several other types of mechanical propulsion were applied to streetcar operation. Steam locomotives were used, principally on the New York Elevated system, but were found not to be particularly suitable for street railway work. The use of the steam locomotive persisted, however, for some years after the introduction of electricity. In 1890, there were 711 miles of urban passenger railway in steam operation. The mileage dwindled year by year to 169 miles in 1902, and to 76 miles in 1912. This type of locomotion has now virtually disappeared. Streetcars operated by storage batteries, by compressed air, and by several varieties of chemical motors were used experimentally, and to some extent commercially, but the invention and successful use of the electric street railway car put an end to further experiments in these directions and the street railways tended rapidly to become electric railways.

In 1888 the first commercial electric street railway was established in Richmond, Virginia, by Frank J. Sprague, following several years of experimental operation of electric cars by Edison, Van Depoole, Henry, Daft, Short, and other inventors and experimenters. These experiments and the pioneer commercial venture ushered in a new period in urban street railway transportation. Between 1888 and 1890 the mileage of electric street railways increased from 29 to 1,260 miles, constituting over 15 per cent of the total street railway mileage of approximately 8,000 miles. In the decade between 1890 and 1900 the mileage of electric street railways increased fifteen-fold and constituted 95 per cent of the total mileage of all street railway systems in 1900, as compared with 15 per cent 10 years earlier.

The development of the electric railway industry can be conveniently divided into several periods characterized by broad economic changes. The periods are not distinct but tend to blend into one another and to vary as to time in different cities. The first period, prior to 1900, was a period of experimentation,

adoption, and establishment. Franchises for the operation of horsecars, cable cars, and trolley cars were obtained in large numbers. In many cases a number of franchises were granted to different promoters to operate lines over various streets of the cities, and in some cases, over the same streets. Changes from horsecar to cable-car or to electric-car operation and the consolidation of lines were often accompanied by refinancing and the sale of additional securities. The properties were not infrequently poorly managed from an operation standpoint, and prodigal and corrupt financial practices were not uncommon. Competition among the small operating companies was keen and they were often involved in local politics to the detriment of the industry and the municipalities.

The second period, from 1900 to 1910, was one of readjustment and stabilization. The securities of street railways were distributed among investors and speculators and many proved to be unprofitable investments, although certain well-located street railways prospered in spite of indifferent management and overcapitalization or maladjusted capitalization. There were, of course, as notable exceptions, soundly financed, well-managed, and splendidly operated properties. As a result of bad or corrupt financial management, there were numerous bankruptcies and receiverships of street railway companies. Consolidations and mergers tended to increase the size of the operating units and to reduce the number of separate lines, which fortunately tended to eliminate the payment of multiple fares by the streetcar riders, as well as to give the industry a stronger financial structure and more efficient management. A widespread public demand for better service and technological improvements conspired to produce faster schedules, more comfortable equipment, and better fare practices toward the end of the period, and public service or public utility commissions, organized in a number of states, were given authority to regulate the services and rates of street railway as well as of other railroad lines.

The third period, from 1910 to 1917, was a period of much greater promise for the street railway industries. Financial excesses of the previous periods had caused widespread dissatisfaction inside and outside the industry, and the managements of street railways turned their attention to improvements in operating efficiency in order to earn a return upon the capital

invested by decreasing operating costs. A new group of operating executives came into control, many of them being men who had risen from the operating ranks, and they were concerned mostly with practical operation. Revenues tended to increase with the growth in size of the cities, increasing population, and improved riding habit, and operating costs were decreased, thus placing the industry upon a sounder basis than formerly.

A fourth period, 1917 to 1923, was a very difficult one for electric railway companies. From 1914 onward the World War had stimulated American industry and had caused rapid increases in wages and in the costs of materials. These continued to rise steadily after 1917. The situation was further aggravated by rapid increases in the registration of private automobiles and by the introduction of the "jitney" bus. Private automobiles diverted an appreciable amount of passenger traffic from the electric railway lines, and the competition of the jitneys was especially destructive because they were usually operated over relatively short routes where traffic was heaviest, the most profitable areas of electric railway transportation. The street railways were forced by regulatory bodies to operate in the areas of lighter traffic density where operation is less profitable or even actually unprofitable and to compete for the traffic with the jitneys in the areas of greater traffic density. The rising labor costs, increasing materials costs, and diversion of traffic caused the street railways to break away from the traditional 5-cent fare and to establish higher rates, but this change in policy tended still further to divert traffic to the jitneys.

The period of general prosperity from 1923 to 1929 did not favor the electric railway industry to the same extent that it benefited other industries. The decline of the jitney was followed by the development of urban transportation by bus. Profits from well-located lines in good traffic territories were often swallowed up in the deficits incurred in the operation of routes in outlying areas or in sections of poor traffic. Moreover, the operation of streetcars in the downtown districts became more difficult and more costly because of street vehicular congestion, the vehicles which took away large numbers of potential street railway riders making a bad situation worse by increasing

traffic congestion. The active competition of motorbuses with the street railways caused the latter to turn to plans of coordinating the electric railway and the motorbus services as a means of self-preservation. Of this more will be said later. New types of fares and other traffic-stimulating devices were extensively used in this period in other to increase car riding.

The period from 1929 to the present has been one of further acute distress to the hard-pressed street railway industry. The economic depression has found the industry as a whole poorly fortified to meet the new crisis. Motor competition has not abated, and receivership and bankruptcy, abandonment, reorganization, and retrenchment have been recurrent items of news in the daily newspapers and trade journals. The leaders in the electric railway field have not given up, however. They have concentrated attention upon improved equipment and public relations as means of checking declining revenues.

It has been frankly recognized that the present difficulties of electric railway companies are in large measure due to the antiquated equipment which they operate. The average age of electric railway cars in use in 1932 was 19 years, as compared with an average age of 7½ years in 1900. The average age of cars in use in 1933 had fallen to 17.6 years, but this was due chiefly to the large number of retirements. Purchases of new cars, which for the entire electric railway industry amounted to about 5,000 cars per year from 1890 to 1902, and 4,000 per year from 1902 until the beginning of the World War, averaged 2,600 cars per year for the years 1919 to 1924, and only 1,100 cars per year from 1924 to 1929. The number of new cars purchased by the electric railways of the United States declined to 73 in 1933, and to 50 in 1934.[1] This situation has been responsible not only for high operating and maintenance costs, but for loss of traffic due to slowness, discomfort, and noise. Out of a realization of these facts the Electric Railway Presidents' Conference Committee was formed to conduct research in the improvement of urban electric streetcar design. An engineer free from the traditions of the industry was placed in charge of the research, and after about 5 years of work, cars embodying many new features were produced. A few of the new cars have

[1] *Transit Journal*, vol. 78, No. 1, pp. 10–11; and vol. 79, No. 1, p. 8.

been installed in Cleveland and Chicago and their performance is being carefully checked.

The number of new streetcars ordered in 1935 was small, but purchases of new transit equipment in 1935 amounted to more than 4,800 passenger vehicles, the largest number in any year since 1912. Of these, 3,800 were motorbuses; 200 were trolley buses; and 751 were rail cars, of which 100 were streetcars and 651 rapid-transit cars.[1] However, that the street railway industry still faces a serious problem of replacing obsolete equipment is evidenced by the fact that it is now operating some 37,000 streetcars that are more than 15 years old, and 10,000 buses more than 5 years old. In the modernization of street railway systems from the equipment viewpoint, the motorbus, and to a lesser degree the trolley bus, will play important roles. The part to be played by the electric streetcar will be determined only by the success which attends the commercial tests of the newly developed equipment designs.

According to data collected by the Bureau of the Census, 485 companies engaged in the operation of electric railways in 1932 reported 31,547.82 miles of rail track and 244.31 miles of nonrail trolley-bus route, with 79,984 cars and 247 trolley buses operated. They carried 9,888,535,364 passengers, of whom 7,955,980,642 were revenue, and 1,932,554,722 free-transfer or free passengers. Principal statistics for the electric railways of the United States, as reported by the Bureau of the Census, are shown in Table 20.

At present the street electric railway industry is in serious straits and its future is difficult to predict. The most recent comprehensive report on the industry was prepared by the staff of the American Electric Railway Association under the direction of an advisory committee, in response to an invitation from the Special Committee on City Passenger Transportation of the Chamber of Commerce of the United States. This report indicates that for exclusively urban electric railway systems, over an 11-year period, 1921 to 1931 inclusive, while the respective showings made by different groups of companies were generally bad, they became progressively worse as the size of the cities decreased. In the group of street railways operating in cities of over a million population the trend of gross earnings from 1922 to 1929 was progressively upward, and the

[1] *Transit Journal*, vol. 80, No. 1, p. 1.

TABLE 20.—SUMMARY, ELECTRIC RAILWAYS, 1907–1932

Item	1932	1927	1922	1917	1912	1907
Number of companies, total	706	963	1,200	1,307	1,260	1,236
Operating	485	682	858	943	975	945
Lessor	221	281	342	364	285	291
Miles of line operated	20,110.38	27,947.63	31,264.26	32,547.58	30,437.86	25,547.19
Miles of single track operated, total	31,547.82	40,722.30	43,931.86	44,835.37	41,064.82	34,381.51
Operated by:						
Electricity	31,431.56	40,585.45	43,789.08	44,676.51	40,808.39	34,037.64
Cable	39.39	42.95	45.90	45.32	56.41	61.71
Animal traction	....	....	4.02	11.16	57.52	136.11
Steam	72.37	16.90	1.06	41.03	76.34	105.06
Gasoline-engine cars	4.50	77.00	86.06	55.61	66.16	40.99
Gravity	....	....	5.74	5.74		
Employees	182,165	264,575	300,119	294,826	282,461	221,429
Passenger cars	59,692	70,309	77,301	79,914	76,162	70,016
Revenue passengers (including pay-transfer)	7,955,980,642	12,174,592,333	12,666,557,734	11,304,660,462	9,545,554,667	7,441,114,508
Revenue passengers per mile of track (all tracks)	271,258	299,733	288,600	252,323	232,556	216,522
Operating revenues	$566,289,989	$927,773,887	$1,016,719,092	$709,825,092	$567,511,704	$418,187,858
Operating expenses	$442,606,685	$694,460,422	$727,795,168	$452,594,654	$332,896,356	$251,309,252
Ratio of operating expenses to operating revenues (percentage)	78.2	74.9	71.6	63.8	58.7	60.1

Source: Bureau of the Census "Electric Railways and Motor-bus Operations of Affiliates and Successors," 1932, p. 4.

margin of net earnings above fixed charges showed distinct improvement through 1929 until the gross earnings were decreased by the industrial conditions of 1930 and 1931. Distinct improvement in operating expenses and maintenance was shown for the 6 years preceding 1930. In the group of companies operating in cities of 500,000 to 1,000,000 population gross earnings were maintained at a fairly constant level through 1929, with only slight recessions from the peak year of 1923. Economies in operating and maintenance expense, and reduction in fixed charges during the last 6 years of the period by the companies in this group brought about a material, though not adequate, improvement in net revenues above fixed charges for the 4 years, 1926 to 1929, over the preceding 5 years.

In the group of companies operating in cities of 250,000 to 500,000 population marked decreases in gross earnings occurred during the years following 1924. However, as a result of decreases in operating expenses and maintenance, due in part to the increased use of one-man cars, and to relatively large decreases in fixed charges through reorganization, the margin of net earnings above fixed charges showed a relatively favorable and improving condition until 1930. In the group of companies operating in cities from 100,000 to 250,000, and in the group operating in cities from 50,000 to 100,000, the decline in gross revenues after the peak of 1923 reached alarming proportions. As in the case of the companies in the preceding groups substantial economies were effected, but in several years during this period the net earnings of these companies were not sufficient to meet fixed charges.[1]

A further indication of the financial condition of electric railways (interurban and urban included) is given in the record of electric railway receiverships. During the years 1915 to 1931, inclusive, 308 electric railway companies were placed in receivership, with 19,268 miles of single track involved, and $763,671,739 in stocks, $1,005,460,605 in bonds, and $3,648,979 of receivers' certificates; or a total capitalization of $1,772,781,323. The percentages of the total capitalization of the electric railway industry in the hands of receivers at the end of each year for the years 1912 to 1931, inclusive, are shown in Table 21.

[1] A. E. R. A., "The Urban Transportation Problem," New York, 1932, pp. 22–28.

The Motorbus in Urban Transportation.—The growth in the use of the gasoline motorbus for local transportation has been mostly a development of the post-war period. At first a competitor of the street railway, it has come to displace the latter

TABLE 21.—PERCENTAGE OF ELECTRIC RAILWAY INDUSTRY IN HANDS OF RECEIVERS, 1912–1931

End of year	Percentage of total capitalization	End of year	Percentage of total capitalization
1912	1.83	1922	16.98
1913	2.59	1923	9.23
1914	2.21	1924	7.24
1915	2.78	1925	6.49
1916	2.54	1926	7.73
1917	2.67	1927	5.96
1918	6.72	1928	5.96
1919	13.41	1929	6.03
1920	14.90	1930	7.59
1921	17.10	1931	7.96

Source: A. E. R. A., "The Urban Transportation Problem," p. 29.

altogether in most of the smaller cities which formerly had electric railway systems, and in some fairly large cities. In the larger cities motorbuses have displaced streetcars on many routes. By Jan. 1, 1931, there were in the whole United States about 232 cities and towns which formerly had had streetcar service but which then had none. The great majority of these communities had less than 25,000 inhabitants, 35 having between 25,000 and 50,000 and 3 having between 50,000 and 100,000 inhabitants.[1]

The change-over from rail to motorbus or trolley-bus operation has continued apace since 1931. This development is especially noteworthy in that the change-over since 1931 has taken place almost altogether in cities of 25,000 population or more, the change having been made in practically all the smaller cities before that time. On Jan. 1, 1936, of the 376 cities in the United States of 25,000 population and over, motorbuses and trolley buses provided all the local transit service in 125 cities, or about 33 per cent of the total number. Of these, 94 had

[1] *Transit Journal*, vol. 80, No. 1, p. 17.

populations from 25,000 to 50,000; 22, from 50,000 to 100,000; and 9, from 100,000 to 250,000. Statistics of track and bus route of transit lines as of Jan. 1, 1936, are presented in Table 22.

TABLE 22.—TRACK AND BUS ROUTE MILEAGE OF TRANSIT LINES, JAN. 1, 1936

Territory served	Miles of electric track			Miles of route		Total miles
	Surface line	Rapid transit	Sub-urban R. R.	Trolley bus	Motor-bus	
Cities over 500,000 population	6,992	1,280	3,619	99	3,513	15,503
Cities of 100,000–500,000	7,268	....	.....	340	8,487	16,095
Cities of 25,000–100,000	2,939	..	....	150	6,259	9,348
Communities of less than 25,000	519	.....	...		1,876	2,395
Interurban areas	7,995	..	...		6,385	14,380
Total for United States	25,713	1,280	3,619	589	26,520	57,721
U. S. possessions	95	..	..	3	74	172
Canada	2,276			..	1,726	4,002
Grand total	28,084	1,280	3,619	592	28,320	61,895

Source: *Transit Journal*, vol. 80, No. 1, p. 15.

The early development of motorbus operation was the work mostly of independent operators, but as time went on many electric railways bought out the independents in their territories and developed bus services of their own, either directly or through subsidiaries or affiliates. At present, by far the greater part of the bus business in cities is conducted by the systems furnishing complete transit service to their communities. Of 1,832,500,000 transit bus passengers carried in the United States in 1935, 1,521,000,000 passengers, or 83 per cent, were carried by electric railway systems, the balance being carried by independent operators. The bus passengers represented nearly 15 per cent of the total transit passengers in 1935. The transit passengers carried by other agencies in 1935 were as follows: surface cars, 7,895,500,000; rapid transit, 2,346,000,000; suburban railroad, 185,000,000; and trolley bus, 55,200,000. The extent to which electric railways have expanded their bus operations is further illustrated by selected comparisons of the operations of 53 companies which began bus operation

before 1925. For these companies in 1931, as compared with 1925, the number of buses owned had increased 246 per cent; total bus miles operated, 303 per cent; total passengers carried, 348 per cent; revenue passengers carried, 326 per cent; and total operating revenue, 305 per cent.[1]

Although the gasoline motorbus has superseded the streetcar in many of the smaller cities, experience does not as yet indicate the dividing line of city populations below which buses are more suitable than street railways for local transportation. However, the motorbus has shown itself to be a valuable vehicle for many forms of local transportation service as an adjunct to other transportation agencies, even in the largest cities. The bus has the principal advantages of flexibility in routing, flexibility in operation on city streets, curb loading and unloading, lower fixed charges, and flexibility in investment, since new facilities require for the most part merely the additional investment necessary for new buses. It has the disadvantages of shorter life than streetcars, higher maintenance costs, lower carrying capacity, and inflexibility in loading during rush-hour periods because of the inability to provide for many standees.

The Trolley Bus in Urban Transportation.—In addition to gasoline motorbuses many electric railway companies have installed trolley buses where streetcar operation has been unprofitable. Experimental work had been done on trolley buses before the World War, and a few commercial installations were made during 1923, but the early trolley buses were crude vehicles. With the development of improved buses, however, many installations have been made since 1927. As of Jan. 1, 1936, there were in operation in the United States 648 trolley buses. These were installed mostly in the cities between 100,000 and 500,000 population, although certain installations were made in some of the largest cities. Together they operated some 589 route miles, with 66 additional miles planned.[2] One of the interesting new developments in transit equipment is the so-called "all-service vehicle," a combination motorbus and trolley bus. Such buses have been used as trolley buses on the city end of a line and as motorbuses in the suburbs. The devel-

[1] A. E. R. A., "The Urban Transportation Problem," New York, 1932, p. 36.

[2] *Transit Journal*, vol. 80, No. 1, pp. 15, 16, 19.

opment of the trolley bus is of importance not only to transportation companies, but to companies which supply electric energy. In 1917, the revenue from power used in street transportation constituted nearly 8.1 per cent of the total electric light and power revenue in the United States; in 1932, it constituted only about 2.3 per cent. During the same period the number of streetcars operated had decreased from 80,000 to 65,000.[1]

The operation of trolley buses shows the best financial results where the initial investment for them is no greater than the cost of modernizing existing rail facilities. This is due to the fact that they permit the use of the streetcar facilities, such as carbarns, shops, overhead power distribution, substations, transmission and power plants. Trolley buses combine many of the advantages of gasoline buses and streetcars. They are less noisy than gasoline buses, and are free from the odors of exhaust gases. They can accelerate faster and more smoothly than gasoline buses, due to the availability of unlimited power from a central station, and have equal maneuverability in city streets over an area covering 10 feet on either side of the center of the overhead trolley. Also, the trolley bus has a longer life than the gasoline bus. As compared with the streetcar, the trolley bus is lighter, thus reducing power costs; it does not require the maintenance or rebuilding of tracks; it can be operated at faster schedule speeds; and it has greater maneuverability.

The streetcar, trolley bus, and gasoline bus do not have exact, well-defined fields of application, since local conditions largely determine the most economical type of agency to be used. It may be said, however, that as a general rule the field of the trolley bus lies between that of the gasoline bus and the streetcar in a coordinated transportation system. The gasoline bus requires a minimum investment for a new installation and thus may best apply to initial operation of feeder lines, cross-town lines, etc., where the purpose is to give service with a minimum investment, and where the amount of traffic is uncertain. As soon as passenger traffic is built up and it is advisable to provide a more fixed form of transportation, the trolley bus provides a proper and economical application. Where abandonment of streetcar service is under contemplation, choice between the gasoline

[1] Clardy, W. J., A Market Worth Retaining and Building, *Electrical World*, Dec. 31, 1932, pp. 892–893.

bus and the trolley bus rests upon a consideration of numerous cost factors, many of which are affected materially by local conditions, as well as customer likes and dislikes. Generalization is thus impossible.

Neither the field of the trolley bus nor that of the gasoline bus extends to that form of mass transportation which because of economy and necessity demands multiple-unit operation or a large number of units operating at close headways during rush hours. The greater capacity of streetcars, and the greater passenger-capacity flexibility, due to the number of standees which may be carried during rush hours, make this agency the only feasible one for mass transportation in the congested portions of large cities, excepting of course, agencies for high-speed transportation. The load limit for motorbuses is a function of both vehicle and roadway, whereas the load limit of a streetcar is a function of the ability of passengers to get aboard. As between the streetcar and the trolley bus, where track and paving renewals and new-car purchases require extensive capital investment, and where passenger traffic on the lines has decreased or is steadily decreasing, the trolley bus may constitute an economical application. In most cases the line construction can be modified by adding an additional contact wire with its insulators, and the new investment required will need be only sufficient in amount to cover these costs and those of new buses, which are about the same as those for streetcars. Ordinarily, the power-distribution system will be adequate without additions.

Future trends of surface transportation in cities are hard to predict. In general, it may be said that some electric railway lines will be abandoned, and others will be replaced by trolley buses or gasoline buses. As track replacements become necessary, particularly on lines having light traffic, there will be gradual substitution of buses, provided such substitution be not prevented by franchise, lease, or mortgage restrictions. In so far as such substitutions are advantageous they should be facilitated. On lines having heavy traffic not in competition with high-speed lines, streetcars are not likely to be replaced by buses within any period of time which can now be determined. In large, densely populated cities, so far as can be seen at present, there will always be need for mass transportation in units carrying large numbers of passengers. The changes which have taken

place in miles of single track and bus route in cities of over 50,000 population, the revenue miles operated, and revenue passengers carried by streetcars, rapid transit, and buses, for the years 1921–1931, inclusive, are shown in Figs. 6, 7, and 8, respectively.

Coordination of Local Transportation.—In larger cities the most efficient transportation system is a coordinated one in

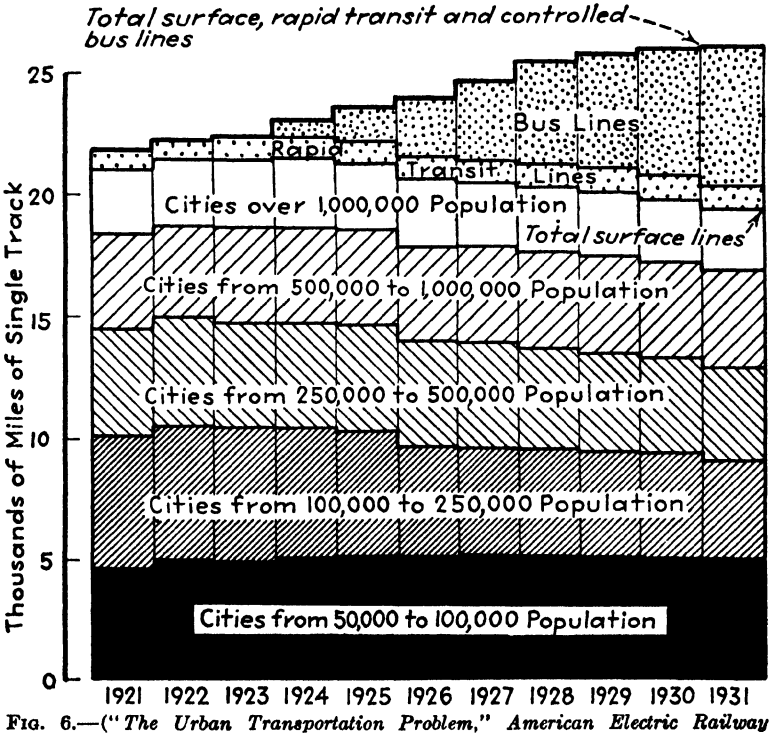

FIG. 6.—("*The Urban Transportation Problem,*" *American Electric Railway Association*, p. 8.)

which the streetcar, the trolley bus, and the gasoline bus are used so that each furnishes that service which it is best fitted to perform. Local conditions, the volume of traffic to be handled, and the load factor on given routes are important factors in determining which agency is to be used in a particular service, but the wisdom of adopting a policy of coordinating the different agencies, rather than of permitting or encouraging competition between them, has been clearly established.

In addition to the tendency, clearly marked in many cities, to coordinate buses and streetcars into a unified system, there is a tendency manifest in some communities to bring all forms of local mass transportation, including rapid transit and taxicabs, under common control for operation. In 1931, electric railways engaged in or controlled taxicab operations in 16 cities, the

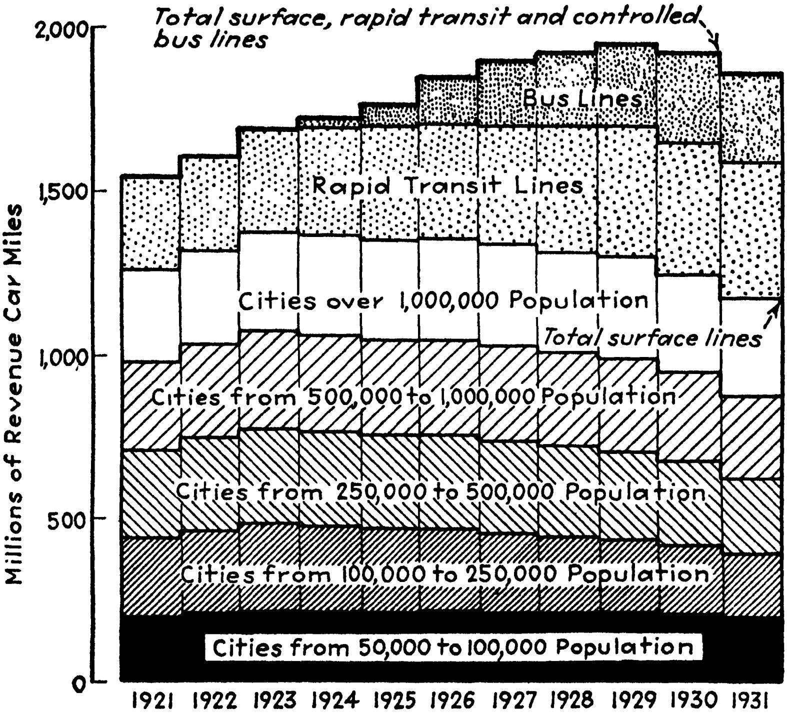

FIG. 7.—("*The Urban Transportation Problem,*" *American Electric Railway Association*, p. 9.)

number of taxicabs controlled by the electric railways ranging from 4.2 to 100 per cent of the total number of taxicabs operating in their respective cities, the total number of cabs thus controlled being 2,155.[1] The advantages of common control of taxicabs and other mass transportation agencies are not so clear as are those of bringing streetcar and bus operations under common control. Adoption of the latter policy is necessary to avoid wasteful duplication of services and uneconomic competition,

[1] A. E. R. A., "The Urban Transportation Problem," New York, 1932, p. 7.

but the taxicab service is not like other local transportation services in many respects. It is largely an individual service; it offers a speedier service than other forms of local surface transportation; it is operated without fixed schedules or routes; and for the most part it requires separate operating personnel. Consequently there are few advantages to unified control.

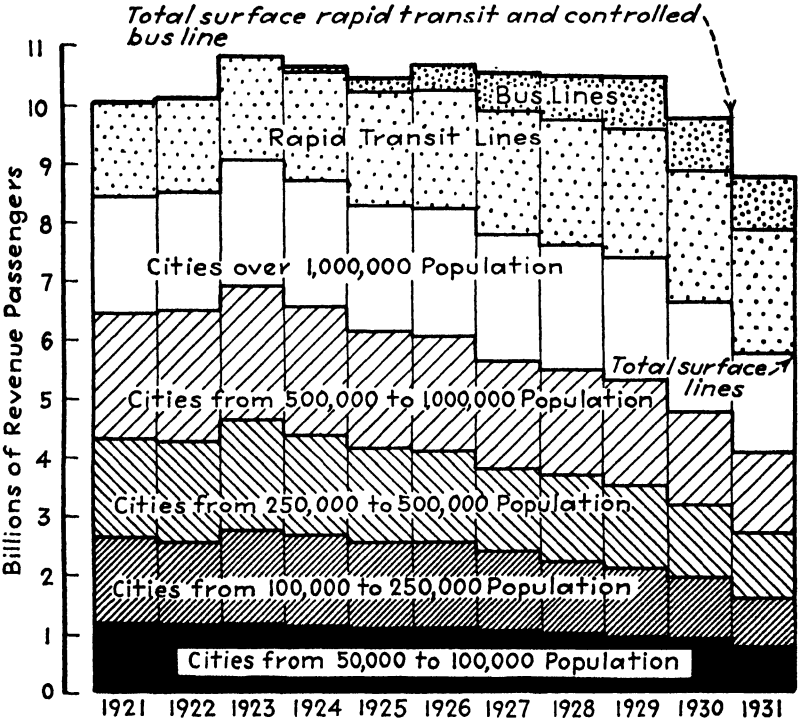

FIG. 8.—("*The Urban Transportation Problem*," *American Electric Association*, p. 10.)

However, it is probable that the extension of electric railways into taxicab operation has been hampered in part by the absence of the type of legislation and regulation which has enabled them to engage in the operation of buses on a large scale. A considerable number of transit companies still operate taxicabs with some degree of success, but it is significant to note that in Philadelphia, where an effort had been made to coordinate all local public transportation facilities, the taxicabs have been sold recently to independent companies. Other large cities which have made

similar experiments and have found such coordination undesirable are Minneapolis and Kansas City, Missouri.

The Service Problem.—The street railway has the poorest load factor of any public utility. Twice a day when most people who use streetcars are going to or returning from work, and then only for a few hours, a street railway company is required to provide facilities and operating personnel far above those necessary to meet average demands upon the system.

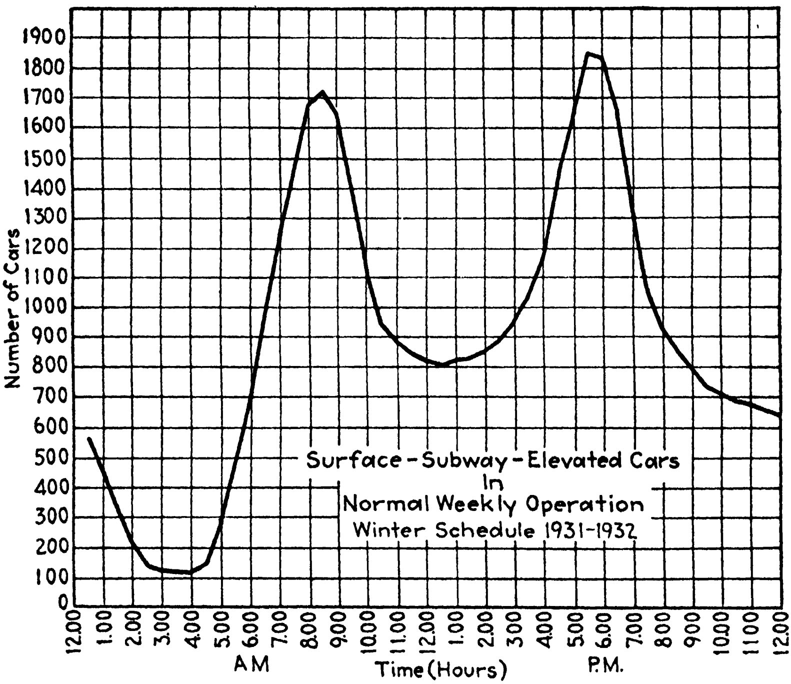

Fig. 9.

Thus in 1931, over 613,000,000 passengers were carried on the surface streetcars in Philadelphia, about 77 per cent of the total passengers carried by mass-transportation agencies, including rapid transit, and about 520,000,000 in 1932. The latter figure yields an average of about 1,400,000 passengers per day, and this means that for about 2 hours each morning and evening passengers have to be transported in Philadelphia at the rate of approximately 125,000 per hour. This traffic is handled by some 1,600 streetcars with a total seat capacity

of 83,000 and an ultimate capacity of 160,000 or more passengers. A very good impression of the uneven hourly distribution of the demands for local transportation in a large city can be obtained from a mere glance at Fig. 9, which shows the number of surface, subway, and elevated cars by half-hour periods which were scheduled for operation in Philadelphia on a normal day during the winter of 1931–1932. The form of this curve is almost identical with that of the power-use curve of a street railway.

It is difficult to consider abstractly the elements of the problem of adjusting urban streetcar service to the needs of the public, since each city presents a different problem. The physical characteristics of the cities, the concentration and diffusion of business and residential areas, the shapes and the ground plans of the cities, working hours, the ebb and flow of employment, shopping habits, and amusement habits are not uniform. Each city must be examined separately and the problem must be approached with complete data upon local conditions in hand. Place data must be laboriously collected by actual traffic counts taken by the platform men (motormen or conductors) as special added duties, by employees of the traffic departments of the electric railways, or by special research organizations which specialize in work of this type.

After discovering the place data, the time data must be compiled. The opening and closing hours of business, educational, religious, and amusement establishments must be known in order to ascertain the time of peak traffic movements. Routes must be laid out or rearranged upon the data collected with respect to the location of the focal points of traffic movements, and "headways," or the time interval between streetcars, must be arranged to adjust the number of cars to the peak or rush hours, and to reduce the number of vehicles in periods of lighter traffic.

It should be borne in mind that it is impossible to place a sufficient number of streetcars in service during the rush hours to provide a seat for every passenger. If this were done the number of cars required would involve a prohibitive investment in equipment which could be used only a small part of the day, and the increased investment would tend to increase the rate of fare. Moreover, the number of cars required to provide a seat

for each passenger during the peak-load periods would produce track and street congestion, and slow down operating speed to an intolerable point. The most that any urban streetcar company can hope to achieve in peak-hour operation is to provide service at frequent intervals, at a relatively high rate of speed without blocks or gaps in service, and with reasonably comfortable standing room.

Efforts have been made by some managements, with varying degrees of success, to spread the peak of rush-hour traffic by seeking the cooperation of municipalities and business concerns and factories in "staggering" the hours at which employees report for and leave work. Under such plans, some employees or the employees of certain concerns start work at 7 o'clock, others at 7.15, still others at 7.30, and so on between 7 and 9.30 A.M. In the afternoon, the places of business or factories release employees at intervals from 4 o'clock to 6 o'clock. Difficulties have been experienced because certain business concerns or employees are unwilling to start and finish work at the times which would be most advantageous from the point of view of the streetcar operator, although many business concerns and employees in a number of communities have cooperated with the street railways in improving streetcar transportation for themselves and others in this way.

Electric railways also have sought to improve peak-hour operation by advertising campaigns to persuade shoppers to start for the shops after the morning rush hour and to leave for home before the evening rush. Attention is called to the obvious fact that if this is done the shoppers will be able to get seats, and they will not get themselves and their packages jostled about and crushed in the avalanche of returning workers.

Express cars are sometimes operated from the downtown centers to suburban districts in rush hours in the evening, and express schedules from the suburbs to the commercial and industrial districts in the morning hours in order to expedite the handling of rush-hour traffic. "Skip-stop" service or service with stops at alternate streets or designated stations is often used as a means of improving service during peak periods although the use of the "skip-stop" and high-speed streetcar service is often restricted by the danger of accidents at the street intersections where the cars do not stop.

Strenuous efforts are directed toward the elimination of the dragging of streetcar traffic by motor vehicles and other street traffic, particularly during rush hours. Municipal ordinances sometimes impose relatively heavy fines for this offense and the police force is entrusted with enforcement. The electric streetcar companies usually have street supervisors to assist in the elimination of vehicular interference, to reroute cars in emergencies, and generally to assist in keeping the cars moving during peak hours.

"Near-side" stopping, improved loading and unloading facilities, improved fare-collection devices, improved facilities for the issuance and collection of transfers or exchange tickets, the coordination of streetcars, subway, elevated, and motor transportation are other devices used to expedite electric railway streetcar operation during the critical periods of rush-hour traffic.

Electric Railway Fares.—Prior to the World War, the usual streetcar fare in the United States and Canada was 5 cents, generally with a reduced-rate exchange or free-transfer privilege, or both. The principal reasons for this rate of fare were its convenience, the deep-rooted conviction that 5 cents was an adequate fare, and the fact that usually a profit could be shown on a fare of 5 cents or less by many electric railway companies. Reduced-rate ticket books which entitled the holder to six or seven rides for a quarter were sold by some electric railway companies. Special rates for workmen, good only during certain hours, such as between 6 and 7 in the morning, and 4 to 5 or 6 to 7 in the evening, were also used in some cities in the United States as well as in Europe. But the rapid increase in the costs of maintenance and operation of the streetcar companies after 1914, and particularly after 1917, made it no longer profitable in the vast majority of cases to operate on the 5-cent fare. Out of 638 streetcar companies in 1923, only 45 had the 5-cent fare, although 20 more companies charged a 5-cent fare, but added a transfer charge. Several of these companies would have abandoned the 5-cent fare but could not do so, because of franchise restrictions.

The circumstances which made departure from the 5-cent fare necessary have been summarized by the Committee on Fare Structures of the American Transit Association as follows:

First, the rapid and unexpectedly severe rise in prices for labor and material due to the World War. Second, the inelastic nature of franchises which called for the supply of services at fixed rates of fare over increasing distances as the area of the cities grew and over which the flat-rate fare could not possibly be economically maintained. Third, the restrictive and cumbersome nature of legislation which had been imposed upon the industry and which hampered the efforts of commissions and other regulatory bodies, in the working out of a satisfactory solution of the problems which confronted the industry. Fourth, the introduction of the private automobile in such vast numbers as to supply an alternative means of transportation for many former patrons.[1] Fifth, the beginning of a new development period in transportation history evidenced by experimental gas buses, trolley buses, and streetcars (such as the Birney) which called for new investments of money. Sixth, the lack of credit of the industry due to the financial results of operations of the few years immediately preceding. Seventh, the increasing burden of taxation and imposts peculiar to this industry.[2]

Rate structures for urban transportation, as rate structures in other public utilities, are affected by both cost and value factors. However, little has been done in this industry by way of cost analysis in determining costs and revenues for different classes of riders and services furnished at different periods of the day, or on different days. It is generally recognized that rates of fare cannot be based exclusively upon costs, nor to the extent followed in the gas and electric utilities, because the value of the service to the rider is a far more important factor. Nevertheless, at present considerably more attention is being paid to costs due to problems associated with the substitution of new types of vehicles for old, and the growth of cities, either by increase in population or by the development of suburban areas.

Cost analyses in the urban transportation industry are not only more difficult to make but the results are not so directly applicable to rate structures as in the gas and electric utilities. Customer costs and demand costs are not readily determined because there is no physical connection with the premises of the customers served and there is no way of knowing when or to what extent a given individual will make use of public transportation.

[1] Jitney and bus competition should also be mentioned but they were local and not nation wide in their effects.

[2] American Transit Association, "Fare Structures in the Transit Industry," New York, 1933, p. 4.

No demand is made directly by any single individual, but by the community, including all residents and visitors, any or all of whom are at any time potential users of the public transportation service. Hence, there is no way of assessing customer or demand costs against individuals, nor of imposing a charge for being ready to serve even though no service is actually taken. It is also impossible to measure the quantity of service rendered in any manner analogous to the metering of gas or electric energy, although some attempt is made in the zoning systems which will be discussed later. Scientific fare structures based on cost analyses cannot be developed in the same manner, nor to the same extent, as in gas or electric rate structures.

Theories Regarding Ideal Fare Structures.—While many different transit fare structures are in use, each may be said to be based upon one or more theories regarding ideal rate structures. The first of these, called the flat-low-rate theory, holds that the ideal fare for any community is the flat-low-rate fare, easy of collection and simple in theory and application. The objective of this theory is to develop the maximum use of the transportation system by setting a uniform fare so low as to render the cost of an individual ride an unimportant consideration. The obvious difficulty in its application is that so low a fare may not yield the necessary revenues, and that unless the community, interested in the greatest good to the greatest number, comes to the aid of the transportation system it may not be able to carry on.

A second theory, called the necessity-rider theory, holds that the competition of other means of transportation, especially the private automobile, has left to street railways and buses the patronage only of those dependent of necessity upon such means of transportation, and that these are affected but slightly by changes in fares. The objective of this theory is to obtain maximum revenues by charging a relatively high fare, easy of collection and with few special privileges. Its expediency is dependent upon the correctness of the assumption that the necessary revenues can be obtained from those dependent upon street railways and buses, without additional revenues from those induced to use the service through fare concessions.

A third theory, called the merchandising theory, holds that the necessary revenues can be obtained only by directing different

types of fares at specific groups of people in a given population. Under this theory various classes of riders are distinguished and many different forms of fares devised to develop traffic from these classes. Opposition to fare systems based upon it comes from those who believe that the complexity of the system, and the opportunities presented for some individuals to take advantage of rates not intended for them, result in no more revenue than would be obtained by a flat fare. Usually such fare systems produce more passengers for a given revenue and unless accompanied by improvement in load factor result in greater operating expense.

A fourth theory, called the total-revenue-per-capita theory, holds that a given community will return a given total amount of revenue to a transportation system whatever the fare or type of fare charged. The advocates of this theory believe that the quality of the service has far more to do with revenue than the price charged.

The rate structures in use are seldom, if ever, based solely upon any one of these theories, although many follow more or less closely the principles embodied in the merchandising theory. An ideal rate structure is bound to be a compromise designed to produce the most satisfactory load factor throughout the day and the best "use factor" by the community. Selective fares for various groups of riders to improve load factor are generally conceded to be essential parts of an ideal rate structure, and the following are some of the groups which have been, or might be, singled out for selective rates:

1. Casual riders.
2. Regular riders.
3. Wholesale riders.
4. Short-distance riders.
5. Off-peak riders.
6. Sunday and holiday riders.
7. Children and student riders.[1]

Wholesale and Regular-rider Fares.—There is no uniformity in the cash fare among transit systems, although 10 cents is

[1] The discussion of transit fare structures given so far, and that which follows, has for the most part been adapted from the excellent treatment of this subject in "Fare Structures in the Transit Industry," American Transit Association, New York, 1933.

becoming an increasingly prevalent rate. "Of the 311 companies in the United States operating in cities of 25,000 population or over according to the 1930 Federal Census 154 operate on a cash fare of 10 cents, 1 on 9 cents, 32 on 8 cents, 60 on 7 cents, 10 on 6 cents, and 51 on 5 cents and 3 have zone systems entirely."[1] In addition to the straight cash fare most systems provide for the wholesale sale of tokens or tickets at reduced rates, the purchaser in some cases needing to purchase only two or three tokens or tickets to take advantage of the wholesale rate. There are very few companies which require the purchase of as many as six tokens at a time, or the outlay of as much as 50 cents, to obtain the wholesale concession. Wholesale rates for tokens or tickets are justified on the theory that wholesale purchasers are likely to be wholesale users of transportation, since the outlay having been made the resistance to further riding has been lowered. However, provision for wholesale purchase of transportation is made through many other fare devices, some of which will now be discussed briefly.

1. The Unlimited Weekly Pass.—The unlimited weekly pass is an arrangement by which the purchaser makes a payment at the beginning of the week for all his rides for the entire week. The weekly pass has the advantages of psychological appeal in that the financial transactions with the company are reduced to a minimum; it creates good will by providing bargain rates for considerable numbers in the community; its simplicity appeals to riders; it speeds up the operation of vehicles and facilitates the loading at heavy points; it holds the possibility of inducing companion riders; it makes for greater use of the facilities of the system during off-peak hours; and it tends to hold patronage. The weekly pass has been criticized, however, on the score that it is an unscientific method of fare determination which reduces unduly the gross revenues of the company. Since it is never introduced as the sole form of fare and the buyer may choose, it appeals, first, to those who are already paying more money to the company per week in cash or token fares than the price of the pass, and second, to the riders who are necessity riders for peak service but who for a small, or possibly no extra charge can have the use of the system at other times. It has been pointed out especially that in most communities there are

[1] *Op. cit.*, p. 82.

messenger boys for stores, telegraph messengers, traveling salesmen, and collectors generally who make numerous rides during the week for which the price of the pass is small recompense. It is only when the pass is sold to riders who would not otherwise pay the same weekly amount for transportation, or to newly induced regular riders, that this form of fare is financially attractive to the transit company.

Sometimes two prices are set for weekly passes on any one transportation system, where the community is zoned and where a higher fare is charged for a longer ride. Another modification of the weekly pass is that permitting unlimited riding within one area of a zone system, with reduced rates outside that area. Still another modification of the weekly pass takes recognition of the fact that there are many families which are unable to travel in the evening, or on Sundays or holidays, without their children but cannot afford to pay fares for them. To meet such demands weekly passes have been sold which permit the holder to take two or three children with him on such occasions free. A compensating factor is that often this results in an additional fare from a companion rider, usually the mother of the family.

2. Sunday, Holiday, and Week-end Passes.—To meet the competition of the private automobile which has wrought vast changes in transit loading on Sundays and holidays, and in some cities on Saturdays, some transit systems have introduced Sunday, holiday, and week-end passes. These are usually issued at the price of several times the average single ticket fare. No attempt is made to relate the cost to the price of the ride, the sole purpose being to set a price which will induce extra riding or use of the service. The daily pass has not been employed for other days, however, which indicates that in the view of the managements its usefulness is limited to Sundays, holidays, and week ends. The universal decline of traffic on these days has demonstrated that the utility of the service is less and that traffic can be stimulated only by additional inducements.

3. The Monthly Pass.—Monthly tickets are in general use in steam railroad commutation service, but monthly passes for street railways have usually had disappointing results. This indicates that a month's outlay for street railway transportation

is a larger amount than any considerable number of riders are willing, or able, to pay at one time.

4. Off-peak Passes.—Some attempts have been made to stimulate the use of transportation facilities during off-peak hours through passes at wholesale rates. Three principal types have been proposed or used: (1) a pass good in any off-peak hours of a single day (that is, between 9 and 4 o'clock in the daytime, and from 6.30 or 7 o'clock at night until the beginning of the peak next day); (2) an evening pass good for the hours of operation after the evening peak; and (3) a weekly pass good only in off-peak hours. While such passes are designed to stimulate off-peak riding it is problematical as to what extent fare reductions can change the riding habits of people. So far as necessity rides are concerned, little hope may be held out for changing the hours, unless it is through cooperation with individual businesses or industries in staggering hours of employment, since workers have little control over the hours at which they ride. The hope of such a fare system is that it will induce people who do not use public transportation systems to do so, and particularly at off-peak hours.

Off-peak rates for a single fare have the same objective as off-peak passes, but with the added advantage that they do not require an investment in more than one ride at a time. This is significant since the appeal of off-peak fares, whether by pass or other fare devices, is for the most part to a group whose use of public transit is likely to be casual or intermittent. In all such devices many operating problems are encountered, since the peaks for all lines of a system are not likely to be simultaneous, and there is always the likelihood of disagreement between employees and customers arising from delays in the arrival of cars and differences in watches. It has been contended in favor of off-peak fares, however, that the operating problems are not beyond satisfactory solution, and that since the public has become accustomed to the timing of transfers, it may also become accustomed to off-peak fares.

5. Family Evening Pass with Graduated Scales.—Another form of wholesale rate of fare which has been suggested is the family evening pass graduated to suit different sizes of families. This represents the application of the wholesale rate to the family as a unit, and thus is different from the applications

previously discussed which are based on the individual. In favor of this fare system is the fact that what business it would develop would come at off-peak hours; and furthermore, that the appeal of public transportation, especially for off-peak riding, is to the family as a unit. It represents an attempt to compete with the private automobile for the transportation of families. The transferable feature of the weekly pass makes it also a family matter, but only one of the family may ride on it at a given time, whereas the family pass is designed to meet family needs.

6. The Permit Card.—Under this system a transferable card is sold for 25 to 40 cents which permits the holder to take rides at a reduced, or wholesale, rate during the life of the permit, which is usually limited to a week. It represents a combination of a readiness-to-serve charge (the price of the card) and a wholesale rate. This system is more scientific than the weekly pass in that the company receives payment for each ride and for readiness to serve. The more the holder rides, the cheaper each ride becomes in that the readiness-to-serve cost is distributed over more rides; but this also contributes more to the company, which is not the case with the weekly pass. It is interesting to note, however, that the permit card while more satisfactory from the viewpoint of cost analysis is not as correct psychologically. It has been the experience of companies which have tried this system that the average number of rides taken, even in the days when factories and offices were operating on a six-day-week schedule, was seldom in excess of 16, with the average for regular shop and office workers not much in excess of 14, or 2 more than the necessity rides. This is in contrast with an average of 22 rides common on weekly passes.[1] It would seem, therefore, that the permit card is not an effective patronage producer.

7. The Weekly Punch Card.—The weekly punch card usually consists of a piece of cardboard with various numbers of rides indicated on it, one of which is punched each time a ride is taken. The price of the card is less than the cost of the same number of rides taken separately. In this form also may be included a readiness-to-serve charge and a wholesale rate. The punch card is usually good for all hours of the day, although

[1] *Op. cit.*, p. 77.

it may be restricted to off-peak hours. The unit period of validity is usually a week.

Distance Fares.—There are in existence many fare systems designed to graduate charges in accordance with distance traveled by establishing zoning systems with a separate charge for each zone. Contrary to a more or less general opinion, however, fares graduated to distance within a community are not based primarily upon cost to the operating company, but upon the value of the service rendered the rider. The increment increase in cost of carrying a passenger a distance of 3 or 4 miles rather than 1 mile is negligible upon a given line on which service is being maintained, providing there is room to accommodate him. This is especially true in off-peak hours and in the case of traffic moving in the direction opposed to the main flow of traffic during rush hours. The principal advantage of a zoning system is that it tends to encourage short-distance riding, a very profitable form of patronage to the company, by lower charges for short rides than would be necessary under a flat city-wide charge.

Zoning systems, with short zones, are in vogue in the British Isles and on the continent of Europe. Tickets are purchasable for any number of zones and the practice is almost universal of charging less per zone for a long ride than for a short one. In the United States the nearest approach to the European zoning system for city-wide fares, is the two-zone system. Under this system the city is divided into a business area and an outer, mostly residential area. A low fare is charged for travel within each zone and a fare for travel from one zone to another less than the sum of two zone fares. No American city has followed the European plan of cutting up the entire system into short rides. A modification of the two-zone system is the establishment of downtown zones only, where a ride may be taken at a fare lower than the system fare, the purpose being to develop short-distance riding in the business section. Another modification is to establish subcenter zones, in recognition of the existence within larger communities of definite centers of community interest, usually containing retail stores, sometimes a department store, churches, schools, and places of amusement. With all such limited zoning systems, however, unless the lines are contained within the restricted zone established, difficulties of fare collection are likely to arise.

Miscellaneous Fares.—A number of cities have a single rate of fare as the rate structure, except in the case of school children or children under a certain age or height. Among those in which a 5-cent fare prevails are New York, Newark, Jersey City, and San Francisco. Baltimore has a flat fare of 10 cents. Transfer privileges are not uniform in these cities, since in several, more than one company operates, and while transfers between lines of the same company are common, transfer privileges between the lines of different companies are closely restricted.

Transfers are in almost universal use on street railway systems, the purpose being to permit the rider to use two or more vehicles for a continuous journey in substantially the same direction. Usually a time limit is set, and definite transfer points indicated. For the most part transfers are free, but the free-transfer privilege has been much abused through sale to parties not entitled to them. For this reason, as well as to increase revenues and to raise the charges to certain riders, many companies have introduced the practice of charging for transfers. In one city the company has liberalized the transfer by eliminating all restrictions upon direction, even as to a return journey upon the original line. Thus a passenger could ride as many times as he chose within the life of the transfer.

The justification for the transfer is clear. In mass transportation it is impossible to carry all passengers directly to their destinations, since many cities are so constructed that a rider must complete his journey on a line running in a direction perpendicular to the line originally boarded. There is no sound reason for charging one who has to use two or more vehicles to complete his journey more than one who can do so on one vehicle, especially since the former is already inconvenienced by the delay and discomfort of making the change.

Off-peak rates to develop traffic in off-peak hours have been mentioned previously. A type of rate frequently suggested also to improve utilization of the company's vehicles is the so-called "opposite-direction" rate. This proposal involves a lower rate for travel during rush hours in the direction opposite to the main trend of riding. The difficulties of applying such a rate on systems where some lines do not have a clearly defined trend of traffic flow are obvious.

It is a general practice to allow school children to travel at specially reduced rates, although such rates cannot be justified on the basis of cost analysis. The costs of carrying school children are about the same as for adults, and for the most part their riding coincides at least with the morning peak. This type of fare is used mostly because of sentiment and tradition, and represents a contribution of the company to the education of the youth of the community. It has been argued that no such requirements are made of other utilities, except in rare cases, and that the community should be called upon to bear with the company a portion of the costs of carrying students at reduced rates.

It is common practice also to allow special rates for children under a certain age or height, but the justification for such rates of fare is much more sound than in the case of student fares. Such children usually travel with adults; they represent the family use of transportation, since they enable adults who cannot afford to leave juveniles at home to take them along at reduced rates; and for the most part they travel in off-peak hours.

Many systems employ combination transportation and entertainment fares which represent concessions from the combined ordinary established rates. This practice had its beginning in the development of amusement parks and recreation centers by transportation companies to encourage riding. However, it has been extended to include theaters and moving-picture houses where there is no financial connection, both the transportation company and the amusement company making concessions.

This discussion of rate structures shows clearly that for the most part the managements of street railway systems believe the ideal rate structure to be one in which separate groups of riders are distinguished and rates for these classes are so designed as to bring into the coffers of the company the maximum revenues. The variety of rate forms in use is indicative of some degree of experimentation, but the industry has been criticized frequently for its reluctance to experiment with rate structures. In partial explanation, at least, of this reluctance may be offered the fact that this industry as a whole is, and has been for some time, in serious financial straits, and that times of low or declining earnings are not particularly suitable for experimentation.

With improvement in earnings, and especially as gasoline and trolley bus services become more stabilized, changes in rate structures may add materially to net earnings. The ideal rate structure for a given community, however, will need to be developed in the crucible of experience, since operating conditions and riding habits vary from city to city.

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CHAPTER VIII

URBAN RAPID TRANSIT

Urban rapid or high-speed transit is the transportation of passengers between places in metropolitan areas by public carriers operated over roadbeds above or below street levels, at average speeds of 20 to 25 miles per hour. This compares with surface street railway transportation operated at about 8 to 12 miles per hour, and in some cases at even lower speeds. As cities grow in population and expand in size, business and social activities are accelerated and spread over wider geographic areas, while business houses tend to be concentrated in increasingly congested city-center districts. If the masses of population are to be given access, at reasonable rates, to residences, offices, shops, educational and religious institutions, and places of amusement, the city governments and business and other organizations must find ways and means of supplementing the inadequacies of surface transportation with rapid-transit facilities; otherwise, the centralization of economic and social life becomes impossible and communities tend to be broken into localized units by the centrifugal force of slow or expensive transportation.

Rapid transit is a special form of urban transportation which differs in essential particulars from surface transportation. Relatively few cities have reached the size and population where rapid transit has become a pressing problem, but there are a number of cities which are just on the verge of having rapid transit as an important issue. Rapid transit is essentially a public matter: (1) because of the great capital investments required; (2) because of the necessity of integrating the plans of rapid transit with urban housing projects, city zoning, and other public projects; (3) because of the difficulties incident to rearranging electric, telephone, water, sewer, and other public utility wires, pipes, and other facilities; (4) because of the great influence of rapid transit upon city finances, real estate values,

business activity, and other aspects of urban life; and (5) because of the close connection between rapid-transit projects and street construction, vehicular-traffic routing, and traffic regulation. For these reasons urban rapid-transit projects are usually planned and financed as partly public rather than wholly private ventures.

The Development of Rapid Transit.—The first underground railway or subway in the world was built in the world's largest city, London, in 1863, as a short underground steam railway in the congested center of the metropolis. The first subway in the United States was opened for traffic in downtown Boston in 1897. This was followed by the first subway in New York in 1904. The pioneer elevated railway in the United States was built in New York and commenced operation in 1868. It is not necessary in this brief sketch to recount the successive development of the various elevated and subway projects. The principal factors responsible for the development of rapid-transit facilities may be summarized as follows:

1. The growth of the metropolitan areas;
2. The separation of residential and business and amusement districts by increasing distances;
3. The uneven distribution of population over metropolitan areas;
4. The development of industries and residential districts in the outlying sections of the cities;
5. The increase in automobile traffic and street congestion in the central districts of the cities;
6. The desire to increase real estate values by transit improvements; and
7. Civic pride, which has caused cities in some cases to develop rapid-transit facilities to match or excel those of rival cities.

At the beginning of 1936, five cities in the United States had rapid-transit facilities. There were in operation 151 route miles of subway system, and 253 miles of urban elevated railway, with a total subway and elevated trackage of 1,280 miles, and more than 10,000 railway cars. Of the total rapid-transit facilities, the four subway systems of New York accounted for 130 route miles, and the two New York elevated railways totaled 138 route miles, making a combined rapid-transit track mileage in New York of 927 miles. Besides New York, Chicago, Philadelphia, Boston, and Cleveland had rapid-transit facilities,

including either subway or elevated systems, or both. The statistics of rapid-transit systems as of Jan. 1, 1936, are shown in Table 23. In addition to these cities which actually had rapid-transit service, there were a dozen cities in the United States in which rapid-transit plans were receiving serious consideration.

There are in the United States 5 cities with population of 1,000,000 or over; 8 with population of 500,000 to 1,000,000; 24 with population of 250,000 to 500,000; and 56 with population of 100,000 to 250,000 inhabitants. In the first two groups of

TABLE 23.—RAPID-TRANSIT LINES IN THE UNITED STATES

City and line	Route miles		Total track miles	Cars		
	Subway	Elevated		Passenger	Service and other	Total
New York:						
Board of Transportation .	35 51		139 24	800¶	16	816
New York Rapid Transit Corporation*	41 7	.. .	323 00	1,840	59	1,899
Interborough Rapid Transit Co	44 6	116 6‡	400.70	4,448	119	4,567
Hudson & Manhattan Railroad†	8.5	. ...	20.03	324	1	325
Staten Island Rapid Transit Co	0.0	21 6‡	44 71‡	95	0	95
New York Totals. . .	130 31	138 2	927.68	7,507	195	7,702
Chicago, Ill.: Chicago Rapid Transit Co	0.0	81.1	202.54	1,782	47	1,829
Philadelphia, Pa.: Phila. Rapid Transit Co§	8.9	11 8	67.95	465	3	468
Boston, Mass.: Boston Elevated Railway	12.2	10.0	54.74	528	29	557
Cleveland, O.: Cleveland Interurban Railway‖	0 0	11 9	27.61	32‖	3	35
U. S. Totals.	151.41	253.0	1,280.52	10,314	277	10,591

* Rapid-transit lines of the Brooklyn-Manhattan Transit System.

† Also leases a high-speed surface line on the tracks of the Pennsylvania Railroad to Newark, New Jersey.

‡ Operates a high-speed line on the surface on private right of way.

§ Includes the city-owned Broad Street subway.

‖ Operates a high-speed surface line in part on right of way of Cleveland Union Terminal Company. Cars include 25 leased from the Cleveland Railway. The system began operating rapid-transit service on July 20, 1930.

¶ There are on order 500 additional cars for delivery in 1936.

Source: *Transit Journal*, vol. 80, No. 1, p. 30.

cities, rapid transit is either an accomplished fact or an imminent development, but in the third and fourth groups, rapid-transit plans are not likely to be considered in the near future.

One of the best statements concerning the importance of rapid transit to a large and growing city is found in the report upon the situation in Chicago, as quoted in the "Report of the Committee on Rapid Transit" of the American Electric Railway Association (now the American Transit Association) in 1928. The statements made then for a particular city are applicable now to the problems of many large urban centers.

Rapid transit is needed and advocated in Chicago for several reasons. Various forms of development are desirable to fit with the different purposes to be served.

The city is growing in population and in occupied or developed area.

Time wasted in movement by public carrier or private vehicle has a greater value than formerly.

Street congestion and increased costs of living due to waste from traffic delay and retardation are growing burdensome.

Preparations must be made to provide for the future and permit growth to be normal by having continued improvements in convenient transportation.

Checks and analyses show that in the immediate central business district traffic moves more freely than five years ago, and faster even than ten years ago. Yet the speed of the public carriers is lower than desirable due to intersection interference and the number of other vehicles that can use the streets is limited. Further improvements in street arrangement and street use can make great increases in freedom of movement and capacity for public carriers and other vehicles.

Increased street space is undoubtedly desirable and will be in greater demand as the rapid development towards larger buildings brings a greater volume of workers and business in the central area. Already the sidewalk space is too limited for the rush periods on several streets and interference between all three classes of street users, public carriers, private vehicles, and pedestrians, is unnecessarily an aggravation.

Each class must be given free movement on its own level in order that business may be expedited, costs of doing business reduced, growth of the city assisted, and the public welfare improved.

The luxury of individual service by automobile or taxicab has a value that should not be too greatly restrained. The present streets in the busiest areas and reasonable widenings should be available to their maximum capacity for such service since group transportation can

best be given on a separate right of way that avoids all intersection interference and both classes gain speed of movement when segregated.

The pedestrian is served by either of these carriers but only when he gets on foot does he become available for the business activity for which the area exists. He is then the indispensable unit that creates the value of the district and his right to safe, speedy, and direct movement between points has a very high importance. A separate concourse open to all buildings which can permit the shortest possible path between building entrances would have great economic value.

The usual space between the street surface and the subway roof used for cross passageways and for passenger interchange at stations can be used for the full length of each busy street for a pedestrian concourse.

In addition to the other very great advantages, there is the creation of a busy shopping level in the first basement floor of all buildings. This alone will justify a considerable part of the cost of subway construction. . . .

Segregation of classes of moving units with separation of grades greatly cuts costs and increases speed and capacity. For public carriers only electric car or train operation in the central district in subways and on the present elevated should exist. Where the volume over a route can justify trains on satisfactory headway these should be operated and may be supplemented by local service with appropriately located stations. On other routes only single cars or two-car trains can be used, but grouping several lines into one subway in the central area is thoroughly justifiable as a temporary operation.

The central district must have conveniently spaced lines with as large a number of stations as public convenience and operating conditions warrant. Public convenience demands operation of local lines with stations easily reached from any point. The first move then, in building subways, should be to create in the central area as many routes as possible to follow the natural trend of the public movement in its daily business and to give widespread yet intimate service throughout the district in order to promote natural and desirable growth and provide the maximum of convenience.

Each of these units, though temporarily used by surface cars, in order to remove public carriers from the surface of the streets would be built to form part of the ultimate rapid-transit plan and as the conditions justify extensions outward, the subway zone could be extended to suit and promote the development of the city. Since such a development would be part of a coordinated system using the existing surface lines and elevated lines together with future extensons and modifications of these two systems, the natural tendency of the city's development

would not be disturbed nor would any one zone be favored at the expense of the others.[1]

Financing Rapid-transit Projects.—The high cost of rapid-transit facilities causes two difficult financial problems: (1) that of raising the large sums of capital required, and (2) that of distributing the cost of the improvements according to the benefits received and the ability to bear the financial burden. The high cost of rapid-transit development arises from the huge expenses of excavation; the underpinning of buildings and streets to prevent collapse or sinking of the structures on the street surface; the cost of condemning property to widen streets; the expense of relocating electric wires, sewer and water pipes, and other subsurface or overhead facilities of other utilities; the damage to property immediately adjacent to the high-speed lines, due to the interference with subsoil rights in blocking off light and air; the adverse effects of traffic diversion during the period of construction; the rerouting of surface-car lines; and the inevitable operating loss which must be borne until traffic sufficient to support the line is being developed.

Over against these cost factors must be set financial and social advantages of faster transportation for residents and transient visitors, the stimulating effects of rapid transit upon business, the increased convenience of the high-speed facilities, the relief of street-traffic congestion, and the appreciation of realty values in the districts served by the rapid-transit facilities and connecting lines.

It is quite generally agreed that several groups should participate in the cost of developing high-speed transit although there is a difference of opinion as to the groups. The first group consists of the residents or taxpayers of the city as a whole. These should bear a portion of the cost because the additional facilities of transportation add to the economic, political, and social advantages of residence in the community. They should bear such costs in proportion to their ability to pay for community betterments.

A second group which benefits materially by rapid-transit facilities consists of those who use public transportation facilities as means of travel between their residences and places of employ-

[1] A. E. R. A., "Report of the Committee on Rapid Transit," Cleveland, Ohio, Convention, Sept. 22–28, 1928, pp. 57–59.

ment, education, amusement, or recreation. The increased convenience and faster speeds of rapid transit as compared with surface transportation have tangible financial values for car riders, as well as the intangible but nevertheless positive advantages of greater convenience and ease in intracity travel and greater freedom from delay. In a sense, however, the car riders are victims of the concentration of population which makes rapid-transit facilities necessary, and they should not be unduly burdened with its costs.

Mr. Leslie Vickers, economist of the American Electric Railway Association, in commenting upon the position of the car rider, states:

> They [the car riders] have been caught in the centripetal-centrifugal movement [in urban development] and are more or less helpless victims of our modern industrial system. Fate has decreed for most of them places of business well removed from their places of residence and whether this be a matter of free choice or necessity does not alter the circumstances. They need to use a common carrier in bridging the distances between the places where they live and the places where they work, and their leisure hours are curtailed in direct proportion to the time spent in traveling. Hence they are interested in speed and the avoidance of delays. At the present time in most cities [where rapid-transit facilities are not available] they are helpless in the presence of massed automobiles whose congestion sets a slow pace for the common-carrier vehicles, which they are using. . . . Not only is valuable time consumed, but the crowding incident to the number of surface cars that can operate in already congested streets is undesirable from many standpoints and discouraging to the movement which seeks to provide for the worker a home remote from the undesirable factory and business areas. If the welfare of our citizens is to direct our civic activities, and if their best interests from a business and personal point of view are to be studied, more facilities must be provided in most of our large cities for accommodation of those who must travel.[1]

Mr. Vickers' statement in this connection not only indicates the necessity of rapid transit from the car riders' point of view and their responsibility for some of the financial burden of rapid-transit development, but also shows the relation of rapid transit to the community as a whole.

[1] VICKERS, LESLIE, The Economics of Rapid Transit, "Report of the Committee on Rapid Transit," A. E. R. A., New York, 1928, pp. 15–16.

The third group which benefits from the development of rapid-transit projects includes the real estate owners whose lands or buildings are in the districts directly served by the rapid-transit lines. In some cases the properties immediately adjacent to the transit lines are adversely affected through impairment of foundations, encroachment upon property lines, noise, or interference with access to light and air, but generally the value of the properties in the vicinity of the lines is definitely enhanced. It is very difficult to determine the extent of this appreciation or estimate the area affected, since the increases in valuation are only imperfectly reflected by increased property appraisals and the extent of the areas affected is often a matter of dispute. Surveys frequently have been made to determine the effects of rapid transit upon urban property values in large cities where such projects have been undertaken. One such survey by the City Club of New York was reported to the Board of Estimate and Apportionment of New York City and to the Public Service Commission of New York State. This survey indicated that the construction of rapid-transit facilities in Manhattan and the Bronx resulted in an increase in real estate values far beyond the "normal rise" measured by the rise in realty values in the period of seven years prior to the construction of rapid-transit facilities. It found also that real estate values were enhanced in a district about a half mile on either side of the rapid-transit line. It was said that the property benefited could have paid the entire cost of construction of the rapid-transit facilities, and yet have shown a net profit. The question was asked, in view of this fact, whether it would not be reasonable to require benefited property in outlying districts to pay some of the cost of a rapid-transit line built to serve it.[1]

Similar studies in Philadelphia show how the values of city real estate are increased by the development of rapid-transit facilities. The Transit Committee of the Philadelphia Real Estate Board, in a report dated June, 1919, stated that during the 12-year period between 1900 and 1912, the years when the Market Street subway-elevated was projected, constructed, and operated for about four years, the assessed valuation of all real estate in the city of Philadelphia was increased $432,000,000,

[1] City Club of New York, "Report of Committee on Rapid Transit," New York, Oct. 2, 1908.

and out of that amount the increase in West Philadelphia alone (the district immediately affected) was $113,000,000, or more than one-fourth of the total increase for the entire city. That this increased valuation was due largely to the elevated was indicated by the fact that the assessed valuation of properties influenced directly by the Market Street subway-elevated increased as much as 98 per cent, whereas in other sections not so affected valuations during the same period increased only 30 per cent. A similar study made by a group of real estate men, in 1923, of property values affected by the Frankford elevated showed that during nine years prior to its operation the value of properties affected increased more than $42,000,000, of which nearly $24,000,000, or 56 per cent, was directly due to the construction of the Frankford elevated. In 1928, the same committee reported on the increase in property values along the Broad Street subway. In this report the committee showed that of $618,000,000 total increase in real estate valuation in Broad Street subway territory between the years 1914 and 1927, approximately $134,000,000 was due to the projection and construction of the subway.[1]

Further evidence of the effect of rapid transit on real estate values, as shown by the experience of New York, Boston, Philadelphia, and Chicago, is the increased activity in real estate at increasing prices which takes place in the districts about to be served by rapid-transit lines. Similarly, real estate advertising and sales efforts stressing the increases in value in real estate through rapid transit indicate that there is a steady increase in the value of real estate due to the development of rapid-transit facilities and that this fact is appreciated by both buyers and sellers of real property. It is true, on the other hand, that elevated railways in some cases have retarded the increase in real estate values, and that sometimes property owners have urged the removal of the structures at their expense, but in such cases other rapid-transit facilities have been available in the form of subways, so that the objections have been directed towards one type of rapid transit—elevated railways—and not towards rapid-transit facilities in general. In the early days of elevated railway construction in

[1] "Report of the Transit Advisory Committee to the General Conference on the Transit Situation in Philadelphia," May 24, 1930, pp. 61–62.

New York and Chicago, real estate owners sought these facilities as eagerly as present-day real estate owners seek subways to serve the districts in which their properties are located.[1]

A fourth group that benefits from rapid-transit facilities includes the owners of private automobiles who benefit through the relief of street-traffic congestion resulting from the diversion of passengers from streetcars, buses, and other private automobiles to the rapid-transit facilities. The construction of rapid-transit facilities tends to decrease streetcar traffic and reduce the number of streetcars operated over congested city streets. In some cases the surface cars can be removed entirely from certain streets, thus creating more street room and increasing the average speed of automobile operation within the cities.

Indicative of the reduction in surface transportation facilities, and the relief of street congestion in central districts, which may accompany the installation of high-speed transportation facilities is the experience of Philadelphia in connection with the construction and operation of the Broad Street subway. The Broad Street Subway Conference Board reported that of $6,777,209 total receipts of the subway for the 37 months ended Dec. 31, 1931, about $5,465,223 came from passengers formerly using surface lines, and only $1,311,986 from traffic created by the Broad Street subway. The Board reported that during this period, as a result of the diversion of surface traffic to the subway, 894,000 bus-miles and 10,920,500 car-miles on surface lines were saved. The saving was altogether on competitive surface lines operating in congested districts, additional service being required on the feeder lines.

A fifth group benefiting through rapid-transit facilities consists of the owners of business enterprises and merchants who gain both as a result of better transportation of customers to and from their places of business and from the relief of street congestion for the better accommodation of their patrons' private automobiles and their own delivery vehicles.

The fact that others than the actual riders benefit from the construction of rapid transit is generally recognized in the form of increased assessments upon property in the vicinity of the rapid transit and increased tax rates generally, if necessary, to finance the projects. There are wide differences, however, in

[1] Vickers, Leslie, *op. cit.*, pp. 12–13.

the groups assessed, in the relative proportions of the assessments, in determining the benefits derived by the property owners, and in arranging for the payment of each group's share of the costs of the rapid-transit facilities. In summary, it may be said that there is general agreement that the following groups obtain special benefits from the development of rapid-transit facilities: (1) the taxpayers of the city as a whole, (2) the owners of benefited real estate, (3) car riders, and (4) the users of private vehicles, including trucks. To these the present authors believe may be added the fifth group pointed out above, namely, the merchants of the city who benefit through improved transportation facilities for their patrons, and through the relief of street congestion for their commercial vehicles.

The proportions of the costs of rapid-transit construction which should be borne by the different groups benefited are difficult to determine because of variations in local conditions and differences in group classification. A plan suggested by the Board of Transportation for use in New York City, proposed the distribution of the cost of rapid-transit improvement as follows:

1. Users of the system would pay all the expenses of operation, all the cost of additional equipment after operation begins, and 40 per cent of the original cost.
2. The city at large would contribute 35 per cent of the original cost in 8 years and would do so without increasing the tax rate.
3. Property along the lines, that would be at least doubled in value, would supply 25 per cent of the original cost and have 10 years in which to pay the assessments.

As to the assessments feature, it surely is not unjust or confiscatory to require an owner of property to pay to the city a small share of the increased value that the new line will produce in his property.[1]

A proposed plan for the financing of rapid-transit facilities in Detroit provided for a distribution as follows:

1. Assessment at large on the city, to cover the benefits derived by the city at large, for one-fourth of the permanent-way cost, consisting of structures and stations, or about 17 per cent of the total cost of underground construction and equipment;
2. Proximity assessment on the local districts, to cover benefits that accrue to the property in the vicinity of the lines, for three-fourths

[1] "Report of the Board of Transportation," New York, 1927.

of the permanent-way cost, or about 51 per cent of the total cost of underground construction and equipment; and

3. Mortgage bonds, to cover the benefits to the rider, for the total cost of equipment, consisting of power stations, transmission system, tracks, signals, yards, shops, cars, and station equipment, or about 32 per cent of the total cost of underground construction and equipment.[1]

A plan proposed for St. Louis submitted by the Board of Public Service to the Board of Alderman of that city was somewhat similar. It proposed the following distribution:

1. Three-fourths of the cost of right of way and permanent construction to be assessed against specially benefited properties in proportion to the amounts by which they will be benefited over and above the general benefit to the city as a whole;

2. One-fourth of the cost of right of way and permanent construction to be paid by public utility bonds of the city, interest and sinking-fund charges on which will be paid out of the general city funds; and

3. All of the cost of tracks, rolling stock, electrical and other equipment to be paid for by the operating company. As this is part of the cost of operating the system, it will come from fares collected from the car rider, who ultimately bears the cost of the service rendered directly to him.[2]

It will be observed that in these three proposals, while there is disagreement as to the proportion of the assessments, there is agreement as to the groups to be assessed. None of the plans provides for any contribution to be made by private automobile owners or merchants, except in so far as they contribute as members of other groups. Determination of the share of these two groups, however, would be very difficult, and their inclusion would add greatly to an already complex problem of cost distribution. Also, no generally accepted formula has been devised for determining the benefits to property owners. One plan for Detroit proposed to distribute the portion of the cost levied upon property owners according to a sliding scale of annual benefit assessments per square foot of land and per front foot for lots of 100 ft. in depth, the rate decreasing by one-half cent per square foot, or 50 cents per front foot, for lots of 100 ft. in

[1] "Proposed Financial Plan for a Rapid Transit System for the City of Detroit, Rapid Transit Commission," 1923.

[2] "Report of Board of Public Service," St. Louis, 1926.

depth, with each successive zone of 264 ft. from the station entrances.

Plans of raising the money for urban rapid-transit projects must necessarily vary because of limits upon city borrowing capacities, assessment policies, the financial structure of the cities, the credit of the cities, and other local factors. The share of the city towards construction of rapid transit is usually raised by taxation; and the benefited property owners' share by real estate assessment, payable usually in annual installments spread over several years. The assessments constitute liens upon the property until discharged. The car riders' share can be paid only as fares are paid for the service and this share cannot be collected in advance. Either the rapid-transit operating company that collects the riders' fares must assume the responsibility or it must be borne by the municipalities that have constructed the facilities. If the municipality both owns and operates the rapid-transit property, there is, of course, no problem in this connection. As a general rule municipalities, if their credit has been soundly conserved, can borrow funds at lower rates of interest than public service companies, due in part to the tax-exemption provisions of municipal bonds.

The bonds for rapid-transit projects, whether issued by municipalities or by the rapid-transit operating companies, should be issued for limited terms of years so as not to outlive the serviceability of the equipment and structures, and thus to saddle upon future generations the costs of worn-out materials. Adequate provision should be made for replacement and depreciation, including obsolescence and wear and tear. The need for limiting the life of such securities has generally been recognized. The North Jersey Transit Commission, for example, has recommended in this connection that the maximum terms of all bonds issued for transit development be fixed at 35 years, without regard to whether the proceeds of the bonds are to be used to finance permanent way, structures, or equipment. "The imposition of long-deferred burdens," the Commission said, "which will fall on future generations who will have abundant current burdens of their own is, therefore, to be avoided."[1]

[1] "Report of the North Jersey Transit Commission to the Senate and General Assembly of the State of New Jersey," 1926.

Subways versus Elevated Railways.—Rapid-transit programs, although they often are accompanied and complicated by street-widening projects, street-elevation plans, and grade-crossing-elimination proposals, usually involve a consideration of the relative merits and demerits of subways and elevated roadways for electric railways. It is impossible to make any direct comparison of the advantages and disadvantages of each type of facility or compare the costs of constructing the different types of facilities, because the needs of communities differ, and costs of construction vary greatly from city to city and from year to year, depending upon physiographical, construction, and financial conditions. Generally subways are much more costly than elevated lines due to excavation costs, the underpinning of buildings, the removal of underground pipes and wires, and greater interference with traffic during the period of construction. Elevated railways, however, are less desirable than subways because of the permanent interference of the structures with the light and air of abutting property owners, the noise of operation, and the interference of the pillars with street traffic. Elevated structures often interfere with the display windows of adjacent shops and other places of business, while subways add another level for display windows and shop entrances, and add to the attractiveness of basement sales floors.

The best available comparative data bearing upon subway and elevated costs are those compiled, in 1925, by the American Electric Railway Association. Changes in price levels both before and after this estimate was made, and irreconcilable differences in local conditions, tend to discount the usefulness of the comparative cost data, but they serve to reflect, if but roughly, the differences in representative costs. In Table 24 construction costs are shown as of the date of construction adjusted to 1925 price levels. They do not include the cost of land condemnation nor building damages other than foundation protection.[1]

Estimates have been made that a four-track subway has a maximum capacity of 100,000 passengers per hour in each direction, and that four subways of four tracks each can carry in each direction 20 times as many passengers as four surface

[1] A. E. R. A., "Report of the Committee on Rapid Transit," 1928, pp. 23–24.

streets for passenger automobiles; hence, the subway is vastly superior to a street-widening project from the viewpoint of reducing traffic congestion. Moreover, the accessibility of

TABLE 24.—SUBWAY AND ELEVATED CONSTRUCTION COSTS PER MILE OF STRUCTURE

City and class	Double-track subway	Four-track subway	Double-track elevated	Three-track elevated
Boston	$ 5,095,200		$1.188,000	
New York:				
Class A	3,820,000	$ 6,070,000		
Class B	5,620,000	9,000,000	1,570,000	$2,020,000
Class C	7,650,000	11,920,000		
Class D	11,250,000	18,000,000		
Philadelphia:				
Broad Street		11,622,000		

"Class A represents subways built in outlying undeveloped districts, where construction can be carried on with little or no interference from traffic, and where few surface structures are encountered.

"Class B represents subways built in developed city residential or small-store districts where street traffic must be maintained.

"Class C represents subways built in congested districts where subsurface structures, traffic congestion, and underpinning of adjacent buildings increase the cost.

"Class D represents subways in congested districts of a business character—with narrow streets—where subway occupies practically the entire width of the street and where underpinning of adjacent tall buildings may be required for practically the entire length of the structure and where structure lies to a great extent below ground water."

Source: "Report of the Committee on Rapid Transit," American Electric Railway Association, 1928.

buildings along the subways would be much greater than along streets widened to accommodate more automobile traffic, and since the value of street improvements to property affected is measured by convenience of access and the concentration of public movement, it can be stated generally that subway development adds more to adjacent property values than do street-widening projects. Another estimate of the traffic-handling capacity of subways as compared with surface streets for streetcars and private automobiles is reported by the Committee on Rapid Transit of the American Electric Railway Association, as follows:

A double-track subway has capacity in one direction equal to the surface-track capacity one way on five streets, using 60,000 passengers for the maximum hours in the subway, and 12,000 per track for surface operation. When a rapid-transit line is built, at least two-fifths of the

surface cars traversing the district served would still be necessary to give local service either on the surface or in local subways.

If on three out of five streets, car service of close headway is removed, the equivalent added capacity for private automobiles in one direction would be 4.5 traffic lanes having 800 vehicles per lane per hour. This would give new space for the movement of 3,600 vehicles, or 6,500 passengers per hour.

The total increased passenger capacity, due to a double-track subway for each direction of rush-hour movement, would then be 60,000 in the subway and 6,500 in private vehicles. The vehicles could create at least as much street-intersection interference as the streetcars removed, so that the cross-town streets would not be relieved.

This improvement due to one subway would, however, be equivalent in service rendered to seven new streets for vehicles such as Michigan Avenue in Chicago, or eight streets like Fifth Avenue in New York, or six streets like Jefferson Avenue in Detroit.[1]

It should be noted in comparing the relative desirability of subway construction and street widening that the costs of street widening are often as great as subway-construction costs. In Chicago, the costs of several street-widening projects were estimated at $8,400,000 per mile. In New York the cost of widening streets to 120 ft. in width was estimated at $2,000,000 per mile. Several of the super-highway projects were several times as high in cost.

Subway Rolling-stock Equipment.—Subway cars are designed to ensure high-speed operation, quick loading and unloading, high carrying capacity in seated and standing passengers, relatively light weight in comparison with carrying capacity, quick acceleration and braking rates, short distances from seats or standing room to or from doors, electric-pneumatic door operation, few guards per train, and the reduction of noise. Modern cars constructed for use in subways in the United States are designed with improved heating, ventilation, and lighting facilities. Construction materials are designed with a view to decreasing weight, and providing high speeds and rapid acceleration and deceleration. Electro-pneumatic braking systems are used so that the electrically operated brake valves ensure simultaneous application of the brake shoes to every wheel of every car regardless of the length of the train in order to avoid

[1] *Op. cit.*, p. 29.

jerky operation. The trucks of the cars are placed near the ends of the cars in order to reduce end swing.

Coordination of Rapid Transit and Surface Transportation.—Rapid transit cannot be regarded as a thing apart; it must be considered as part of an integrated urban transit system, including subways, elevated lines, streetcars, motorbuses, and improved highways. This means, expressed in practical terms, that the routes of the rapid-transit facilities, their schedules, station locations, frequency and headways, and fares, must be integrated with surface transportation facilities. They must be so arranged with respect to terminals, routes, and fares that, to use an analogy, the rapid-transit facilities may serve as the main arteries and veins, and the surface transportation facilities the many smaller blood vessels which reach out and serve all parts of the urban community. The coordination of rapid-transit facilities with streetcar lines and motorbus routes radiating out from key stations of the rapid-transit lines, at fares designed to include rapid-transit and surface transportation, tends to decrease the time required for the consummation of the average passenger trip, to reduce excessive streetcar trackage and car mileage, and to extent the land area within which the urban population may spread without requiring an excessive loss of time in commutation travel.

That proper coordination of surface trolley or bus routes with high-speed routes is essential to the profitable operation of the latter, and the attainment of the most efficient comprehensive system of local transportation, is shown by traffic studies on the Broad Street subway in Philadelphia. The route of this subway is along one of Philadelphia's main arteries of travel and it is used principally by the traveling public for transportation to and from the central business sections. A considerable volume of its traffic comes from directly contiguous territory, but owing to the fact that residences are widely scattered in the territory served a large part of the total volume consists of passengers who use some form of surface transportation in conjunction with the subway. A recent traffic survey showed that out of 149,037 passengers using the subway on an average weekday 34,852 passengers, or 23.38 per cent, made direct subway journeys, while 114,185 passengers, or 76.62 per cent, made combined subway and surface journeys over the lines of the Philadelphia

Rapid Transit system. The total number of subway journeys and the total number of rides by classes of fares are shown in Table 25. Boston and Philadelphia are the only two cities where a combined surface–high-speed ride can be had for a single fare.

TABLE 25.—NUMBER OF JOURNEYS AND RIDES FOR A TYPICAL WEEKDAY ON THE BROAD STREET SUBWAY, PHILADELPHIA

Type of journey	Number of journeys			Number of rides by classes of fare			
				Subways		Surface	
	Direct	Transfer or exchange	Total	Cash and tokens	Transfers and exchanges	Cash and tokens	Transfers and exchanges
Direct subway journeys.......	34,852	......	.....	34,852	......	......	... ...
Transfer and exchange:							
Single transfer and exchange	.....	96,764	....	47,904	48,860	48,860	47,904
Double transfer and exchange:							
Intermediate surface*.....	.....	4,946	... ...	2,448	2,498	2,498	7,394
Intermediate subway†.. ..	....	12,475	.... .	...	12,475	12,475	12,475
Totals	34,852	114,185	149,037	85,204	63,833	63,833	67,773
				149,037		131,606	
	23.38%	76.62%	100%	53.11%		46.89%	
Total rides subway and feeders..	. .		....	....		280,643 (100%)	

* Double-transfer journeys with two surface rides on one end of journey.

† Double-transfer journeys with one surface ride on each end of journey.

Source: Department of City Transit, Philadelphia; Traffic Survey of Broad Street Subway and Surface Feeder Lines, p. 10, 1933.

Rapid-transit Fares.—Generalizations with respect to the rates of fare for rapid transit are difficult to make and dangerous to use because they are apt to be misleading. This is due to variations in the policies of different communities in absorbing parts of the structural costs in the portion of the cost borne by the community or property owners and defrayed out of the proceeds of taxation. All subway and elevated lines have outside collection of fares. In some cases agents sell tickets or tokens and other employees serve the "ticket choppers" or turnstiles. This method has proved to be unduly expensive

and now the prevailing plan is to have station agents in booths make change or sell tokens to passengers. The coins or tokens are used in connection with automatic turnstiles. This is the quickest and most efficient means of collecting fares yet devised. It is possible for more than 2,500 passengers to pass through a single turnstile in an hour if provided with coins or tokens. The straight cash fare, especially if that fare is 5 or 10 cents, is the most desirable and most practical fare plan. When a fare other than 5 or 10 cents is charged, involving the use of more than one coin if paid in cash, tokens are usually sold, either in advance or in quantities or a few at a time at booths near the subway train entrances, by the same agents that receive the cash fares and the turnstiles are adjusted, in such cases, to take the token fares.

In 1934, the straight rapid-transit fares in the cities having high-speed facilities were: New York, 5 cents; Chicago, 10 cents; Philadelphia, 8 cents; Boston, 10 cents, and Cleveland 10 cents. These comparisons are without particular significance unless a detailed analysis is made of the extent to which free transfer or reduced-rate transfer privileges, or both, are available. This is wholly impracticable for the purposes of this discussion, however, because the policies of the companies vary from time to time and from city to city, and, in some cases, from district to district in the same city. The pressure to keep fares down, and at the same time to improve the speed, frequency, and quality of transit services, is constantly felt by the managements of rapid-transit companies.

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CHAPTER IX

INTERURBAN ELECTRIC RAILWAY TRANSPORTATION

PASSENGER TRANSPORTATION

There is no sharp line of demarcation between the urban and interurban electric railways. Certain properties, primarily urban, do a large interurban business, while others, which are essentially interurban in character, provide local transportation in terminal or intermediate towns and cities. Many interurban operations grew out of mere extensions to city electric railway systems, while others were from the beginning truly interurban in character—the systems being established initially to connect centers of population at a distance from one another.

Two distinct effects of the application of electricity to passenger transportation outside of centers of population may be noted: (1) the development of suburban passenger traffic by street railways and the building up of widely scattered suburban districts; and (2) the development and operation of interurban electric railways, which accomplished for the vast rural regions of the United States what the street railways had done for the suburbs.

During the first decade or so of the present century, and especially during the period from 1902 to 1907, the development of interurban electric railway transportation represented one of the leading features of electric railway development. By 1907, track mileage outside of city limits constituted about two-fifths of the total track mileage of the electric railway industry.[1] One of the remarkable features of this early development was the continuity of service afforded, it being possible by 1907 to travel by trolley, with comparatively few interruptions, between New York and Chicago, Boston and New York, Indianapolis and Chicago, Chicago and St. Louis, and between many other large cities separated by considerable distance. In 1912, interurban

[1] U. S. Department of Commerce, Bureau of the Census, "Central Electric Light and Power Stations and Street and Electric Railways," 1912, p. 179.

track mileage amounted to 16,365.80 miles, as compared with 24,699.02 miles of city and suburban electric lines.[1] Developments were most extensive in the East, the Middle West, and the Pacific Coast region. The development of interurban electric railway passenger transportation resulted in some cases in the establishment of sound systems which have carried on to the present, but in other cases systems were established, the economic existence of which was never justified and which eventually were forced to cease operations. In this field, as in so many others, financial exploitation by syndicates resulted in the construction of many uneconomic enterprises.

Many of the earlier interurban roads were built along public highways under county grants, but the practice of using cross-country private rights of way later became quite common. Among the objections to the use of public highways were the short life of grants or franchises, the inability to secure good drainage and grades, the incurring of heavy paving, snow-removal, and other road obligations, and the dangers of operation due to collision, runaways, etc. Often the private rights of way were acquired in territory immediately adjoining public highways, since it usually could be obtained at lower costs than other property; but developments in the direction of high-speed limited cars and long freight trains, made rights of way along the highways undesirable. Cross-country rights of way permitted fencing in on both sides, and the use of grades, drainage systems, and speeds of operation suitable to the needs of the enterprise. Moreover, private cross-country rights of way permitted the roads to eliminate sharp curves, which were objectionable from the standpoint both of high-speed operation and the running of trains of cars. A further problem in routing often involved a choice as to whether it was better to seek a route along the main streets of the towns served or one independent of them. Nearness to sources of traffic favored the former, but speed and safety of operation favored the latter alternative.

Many interurban electric railway systems were constructed so as to parallel as closely as possible steam railroad rights of way in order to compete with the steam roads, rather than to develop and control traffic in new territories. Such routes were laid out in the belief that much traffic could be developed for the electric

[1] *Op. cit.*, p. 200.

lines by offering a more frequent and more flexible passenger service, a more rapid package-freight service, and a feeder service for the main line of the steam railroad, especially in the handling of freight. Many of the interurban railways were, and still are, quite comparable to steam railroad systems, with limited cars making only a definite number of stops between widely separated points. Others were like ordinary street railway systems, making stops at practically every corner or farmhouse.

In the development of passenger traffic most of the interurbans were aided by having a city of at least fair size at one or both ends of the line, while some networks included several large cities. This produced traffic from rural communities formerly deprived of public transportation to the cities, and in some cases considerable riding from cities to rural communities for amusement and recreation, especially where parks or places of amusement were included in the network of lines. Many amusement parks were constructed directly or indirectly by interurban lines to stimulate riding. The size of the contributory interurban population in most cases was limited to the population of the area within a mile or two of the tracks. Development of the route and track of the interurbans was often complicated by the difficulty of retaining the advantages of the short haul, while developing long-distance travel and securing all the advantages of the long haul. High-speed service was hard to develop where stops were frequent and indeterminate, but the introduction of limited trains for service between the larger towns and cities enabled the interurbans to compete with the steam roads, and brought to them a variety and an amount of business that otherwise they could not have secured.

The interurban trackage of electric railway systems in the United States, as reported by the Bureau of the Census, increased from 16,365.80 miles in 1912 to 18,097.62 miles in 1917, but declined to 17,807.93 miles in 1922. In recent years the interurban trackage has declined steadily, as is shown in Table 26, the total for the United States on Jan. 1, 1936, being 7,995 miles, less than half the mileage reported in 1917.

The number of companies engaged in interurban electric railway transportation, the volume of their traffic, and their revenues also have declined steadily in recent years. Information and statistics on exclusively interurban operation are scarce and

difficult to obtain, partly because interurban and city operations are frequently combined in one system and no separate reports for interurban operations are made. Table 27 presents selected financial and operating data for electric railways reporting to the Interstate Commerce Commission for the years 1925 to 1934. These data are not strictly comparable to census data, since the Interstate Commerce Commission reports include several electric terminal railroads in the Middle West which are not generally regarded as interurbans, and they include all the operations, both city and interurban, of electric railways engaged in interstate commerce, but the figures are indicative of the general situation. Passenger revenues of these carriers declined steadily from $152,967,834 in 1925, to $27,417,001 in 1934, a decline of approximately 82 per cent.

TABLE 26.—SUMMARY OF ELECTRIC RAILWAY TRACKAGE—INTERURBAN
Miles in operation as of Jan. 1

Year	Miles of track	Year	Miles of track
1923	16,032	1930	12,979
1924	15,811	1931	12,259
1925	15,572	1932	11,053
1926	15,226	1933	9,953
1927	14,629	1934	9,683
1928	13,966	1935	8,611
1929	13,217	1936	7,995

Source: *Transit Journal*, January, 1935, p. 21, and January, 1936, p. 15.

The factors responsible for the decline in interurban electric railway transportation are in some respects similar to those which have made for the decline of the whole electric railway industry. Overexpansion, resulting in the construction of uneconomic enterprises, and financial exploitation took their toll of the interurbans as they did of the strictly city systems. Similarly, the rapid development of the electrical arts which rendered equipment obsolete soon after it was installed, and the insistent public demand for better and faster transportation, whether or not the volume of traffic would justify the expenditures necessary for the improvements demanded, added to the burden of the interurbans and eventually forced many of them into receivership and ultimate liquidation.

TABLE 27.—SELECTED FINANCIAL AND OPERATING DATA, ELECTRIC RAILWAYS REPORTING TO THE INTERSTATE COMMERCE COMMISSION
(As of Dec. 31)

Item	1934	1933	1932	1931	1930
1. Number of carriers	123	133	157	176	195
2. Miles of road operated	5,829	5,985	7,391	8,276	8,958
3. Investment in road and equipment	$521,166,673	$543,845,847	$820,010,636	$903,723,484	$977,443,648
4. Freight revenue	15,893,171	15,075,610	17,176,173	23,719,315	31,161,760
5. Passenger revenue	27,417,001	27,560,478	47,135,956	68,175,638	85,676,664
6. Total operating revenue	48,442,015	47,495,617	70,865,505	100,560,892	127,910,623
7. Total operating expenses	46,832,115	46,866,970	66,845,307	90,721,602	112,470,599
8. Net income	13,927,925*	14,793,987*	9,542,385*	1,488,024*	10,673,880

Item	1929	1928	1927	1926	1925
1. Number of carriers	211	223	235	252	260
2. Miles of road operated	10,076	11,591	12,277	13,221	14,074
3. Investment in road and equipment	$1,132,889,698	$1,264,533,842	$1,272,943,916	$1,373,241,756	$1,476,788,493
4. Freight revenue	38,041,868	38,100,802	40,410,824	39,382,332	39,002,544
5. Passenger revenue	102,521,739	116,021,095	126,342,522	138,428,701	152,967,834
6. Total operating revenue	153,433,981	167,173,838	180,886,164	191,949,159	207,446,038
7. Total operating expenses	128,286,941	141,132,849	151,847,259	160,702,288	168,746,459
8. Net income	16,386,227	12,919,412	14,180,365	12,216,134	13,980,204

* Deficit.
Source: Interstate Commerce Commission, "Statistics of Railways in the United States," 1925–1934.

One of the principal reasons for the decline of the interurbans has been the competition of other agencies, especially motor transportation. Motor competition has been felt even more severely by the interurbans than by strictly city lines. The latter often were protected by franchises from the competition of motor vehicles which might engage in public transportation, but not so the interurbans. Especially were the interurbans vulnerable to the competition of the private automobile. The greater flexibility of motor transportation, the greater comfort of the new vehicles, and the lower rates offered wrought havoc among the interurban electric railway systems. As a result, many of the smaller interurbans, and some of the larger ones, were forced out of business, to be superseded by motorbus lines. Others changed over wholly or partly to motorbus operation.

Motorbuses have been coordinated with interurban electric lines in many ways. Many electric railway lines employ motorbuses to perform extension or feeder services to districts outside the cities or towns served directly by the electric railways. These extension and feeder lines have developed traffic and produced indirect benefits. Motorbuses are also used to connect the lines of electric railway that have no direct track connections. Several interurban electric railways operate long-distance de luxe intercity buses and, in some cases, the electric railways operate all-expense motor or motor and electric railway tours of from several days to a week or more in duration. The tours may run through the territory served by the electric railway, or extend the electric railway service. Motorbuses are also used as a complete substitute for electric railway service and the rail service is abandoned.

Perhaps the most extensive use of interurban motorbuses by electric railways has been in the operation of parallel motor and rail services. The purposes of this type of coordination are to eliminate competition, to improve the quality of service, and to reduce operating expenses. The combined railway and motorbus schedules are "staggered" by alternating buses and electric cars. In some cases the motorbuses are operated over short-cut routes to reduce the running time and mileage or to serve territories not on the regular electric railway routes.

The growth in volume of motor passenger traffic handled by electric railways, as reported to the Bureau of the Census, is

shown in Table 28, but unfortunately these data are not broken down into city and interurban operations. The volume of interurban passenger traffic of motorbus companies increased rapidly from its inception until 1931, since when there has been a decline, due principally to the depression. Intercity common-

TABLE 28.—SELECTED STATISTICS, ELECTRIC RAILWAY AND SUBSIDIARY MOTORBUS LINES, 1932, 1927, AND 1922

Item	1932	1927	1922
Number of companies, total	498	301	
Operated by electric companies	268	301	
Directly	173	98	
Through subsidiaries	95	203	
Operated as successors to electric companies	230		
By former railway interests	81		
By independent companies	149		
Routes operated, number	3,613	1,583	100
Miles of route (round trip)	77,896 75	29,266 98	
Miles of street or highway served (one way)	36,652 05	14,298 72	685.36
Buses, total owned and leased	15,064	8,277	
Buses in operation	13,297	7,681	
Average number in schedule service during the year	10,703	6,238	
Passengers, total	1,302,318,486	875,402,229	16,120,115
Revenue	1,147,661,832	784,259,878	12,791,308
Free-transfer	143,728,631	85,235,378	3,252,175
Free	10,928,023	5,906,973	76,632
Bus-miles, total	499,024,928	272,517,688	7,116,404
Revenue	494,922,384	270,482,636	
Nonrevenue	4,102,544	2,035,052	
Average number of revenue passengers:			
Per mile of route (round trip)	14,733.1	26,796.7	
Per mile of street and highway served (one way)	31,312.4	54,848 3	18,663 6
Per bus operated	86,309 8	102,103 9	
Per revenue bus-mile	2.3	2 9	
Operating revenues, total	$99,883,830	$68,120,905	
Operating expenses, total	$94,717,925	$67,252,508	
Operating ratio	94 7	96 6	

Source: U. S. Department of Commerce, Bureau of the Census, "Electric Railways and Motor Bus Operations of Affiliates and Successors," 1932, p 81.

carrier bus-miles, passengers carried, and gross revenues for the years 1927 to 1934 are shown in Table 29.

The interurban electric railways have not altogether surrendered to the competition of other carriers. Many of them have modernized equipment and service and have lowered costs. In this way they have materially strengthened their competitive

position. Attempts to generalize the practices which they have adopted to retain and build up patronage would be futile, but a few are worthy of mention. These include such improvements as the following:

1. Abandoning roadside operations and acquiring private rights of way;

2. Laying heavier rails, usually 80 pounds per yard or over, in order to support higher speed operation;

3. Ballasting and maintaining tracks to promote high-speed operation;

4. Acquiring lighter and faster equipment;

5. Providing cars with better seating arrangements, better lighting and ventilation facilities, and separate smoking compartments, in some cases;

TABLE 29.—SUMMARY OF INTERCITY MOTORBUS OPERATION, 1927–1934

Year	Common-carrier bus-miles	Common-carrier passengers	Common-carrier gross revenue
1927	1,167,000,000	403,000,000	$227,000,000
1928	1,320,000,000	449,000,000	255,000,000
1929	1,342,000,000	497,000,000	285,000,000
1930	1,384,000,000	504,000,000	290,000,000
1931	1,348,000,000	465,000,000	261,000,000
1932	1,270,000,000	422,000,000	247,000,000
1933	929,600,000*	328,780,000†	176,580,000
1934	894,800,000*	378,200,000†	171,200,000

* Revenue bus-miles.

† Revenue passengers.

Source: "Bus Facts" for 1933, p. 5, and 1935, p. 4, National Association of Motor Bus Operators.

6. Adopting high-speed schedules;

7. Adopting "limited" or "non-stop" and local schedules designed to meet the needs of through and local traffic;

8. Improving wayside-station and terminal facilities;

9. Improving and modernizing signal systems, including in some cases block-signal systems and automatic train control;

10. Installing, in some cases, chair-car, sleeping- and dining-car services, in connection with long-distance intercity services;

11. Improving ticket and fare practices through the establishment of fare zones; commutation, school, round-trip, and other

types of tickets; and joint-route and through-rate and through-ticket arrangements with other electric railways and with motor transportation companies; and

12. Developing improved public relations through planned public-relations work.

Interurban Electric Railway Fares.—Several different systems of passenger fare are used by interurban electric railways, including: (1) the mileage basis, (2) the zone system, and (3) the flat-fare system. The majority of electric railway companies in the interurban field use the mileage basis, the rate of fare per mile ranging from 1 to 5 cents, with 3 cents per mile as the most common rate.

Another large group of electric interurban railway companies use the zone system, the lengths of the zones varying greatly with different companies. The characteristics of the zone fare system are: (1) the rates tend to decrease as the distance increases; (2) there is a pronounced tendency to keep the fares at multiples of a denomination of currency such as the nickel or dime; and (3) there is a tendency to charge higher rates of fare for the first zone and lower rates for the succeeding zones. The flat-rate system, which ignores zones and distances, is used by a number of electric railways, particularly by relatively short-distance suburban lines, in order to encourage the development of communities more distant from the cities.

A great variety of special tickets, at less than the standard mileage, zone, or flat rates, are used by interurban railways to encourage regular travel over their lines. These special rates include round-trip excursion tickets, mileage books with or without interchange arrangements, tokens, strip tickets, monthly and weekly commutation fares, reduced rates for special occasions, special picnic or party rates, school tickets, and special combination electric railway transportation and moving-picture theater or other amusement tickets at less than the regular rates for each service.

ELECTRIC RAILWAY FREIGHT TRANSPORTATION

The urban and interurban electric railways of the United States were built primarily, if not solely, for the transportation of passengers. The thought of engaging in freight transportation, except for the incidental carriage of the mails, light express

matter, and small quantities of merchandise traffic, at first did not occur to the managements of the vast majority of electric railway properties. However, a few electric lines began the development of freight traffic 20 years or more ago in competition with steam railroad freight service, and it had been the practice quite early to carry mail on interurban electric cars. The latter practice began with the granting of free transportation to mail carriers with their baggage and developed into a service which in some sections of the country was quite similar to the railway mail service, comprising completely equipped mail cars. Similarly, many of the interurban lines which early engaged in freight transportation began to provide both special and general freight services. Freight depots were constructed and freight trains often were operated on schedule. Many of the cars on these roads were like ordinary steam railroad freight cars with brake equipment, etc., but others were combination freight and passenger cars. The service ordinarily was faster than the steam railroad freight service. Rates on package freight generally were higher than railroad freight rates, but lower than express rates.

Later, the development of hard-surfaced roads and the rapid increase in the number of private automobiles, "jitneys," and motorbuses so seriously depleted the passenger traffic of many other electric railways that their managements turned, sometimes in desperation, to freight traffic to counteract their declining passenger revenues. In many cases, this policy was sound, because the existing facilities, including tracks, terminals, power stations, and electrical transmission facilities, could be used with only slight modification and expansion to accommodate freight as well as passenger traffic, and the force of employees had to be augmented and reinforced only slightly by men with experience in the freight business. The earnings from freight traffic, in many cases, paid adequate return upon the capital invested in freight-station facilities, freight-carrying equipment, trackage extensions, the adaptation of existing equipment to accommodate freight traffic, and other necessary innovations and renovations. The freight traffic, moreover, could often be transported at night or at off-peak passenger-traffic hours so that the load factor and operating efficiency were improved, and the systems used at more nearly their total capacity. Freight traffic

gave to many electric railway lines greater stability and efficiency and enabled them to take advantage of the increasing returns growing out of increased total traffic. However, entrance into the freight-transportation field did not produce this satisfactory result for all electric railways, due to the inefficiency of certain lines in developing the potential freight traffic, to the intensity of the competition of steam railroads, water lines, or motor freight carriers serving the same fields, or to other causes which varied with local conditions.

Types of Electric Railway Freight Carriers.—The electric railways engaged in the transportation of goods fall into several fairly well-defined types. The first type includes the urban-suburban electric lines which, for the most part, transport package freight of miscellaneous character. Many of these companies have abandoned freight service because of interference with their passenger service, or because of the superior service offered by competitive local motor express carriers. It is interesting to note that plans have been proposed within the last few years to establish freight services in some of the larger cities, using the facilities of the streetcar and subway lines to provide pickup and delivery services at night to business concerns located on or near the tracks of the electric lines, in order to relieve the city streets of the congestion caused by daytime delivery and pickup services performed by motor freight vehicles. These plans have not been sufficiently developed to merit more than casual mention here, but they may be significant when the tide of business again threatens to congest the downtown sections of large cities.

The second type of electric railway carrier is the intercity or interurban railway which is primarily engaged in the transportation of passengers but carries freight, often of the package or express type.

The third type includes the large electric railways which transport all kinds of freight in carload as well as in less-than-carload lots as an important part of their business. Many of these carriers interchange freight and cars, and have through-billing and joint-rate arrangements with steam railroads and other carriers. These electric railways are integral parts of the interconnected nationwide railroad freight-transportation system.

Exact statistics of interurban electric railway freight traffic are not available, but the census figures in Table 30 for freight,

mail, baggage, express, and milk, while not broken down for urban and interurban transportation, represent practically altogether interurban service. These figures show an increase in freight revenue of all electric railways from $1,038,097 in 1902 to $39,124,811 in 1927, with drastic falling off to $17,646,882 in 1932. Income from baggage, express, and milk increased by census periods from $401,672 in 1902, to $5,285,086 in 1922. Since 1922 revenues from these sources have declined, largely due to the development of motor freight transportation. Mail revenues increased from 1902 to 1927, but not nearly in the same proportion as freight and baggage, express and milk revenues, the revenues from mail for all electric railways amounting to $432,080 in 1902, and $775,008 in 1927. Mail revenues declined to $556,824 in 1932. These declines constitute evidence of the seriousness of the effects of the depression upon electric railway lines, as well as of the inroads of motor competition.

TABLE 30.—INCOME FROM FREIGHT, MAIL, BAGGAGE, EXPRESS, AND MILK TRAFFIC ON ELECTRIC RAILWAY LINES, 1902–1932

Census year	Total number of companies reporting	Freight		Mail		Baggage, express, and milk	
		Number of companies reporting	Income	Number of companies reporting	Income	Number of companies reporting	Income
1902	799	195	$ 1,038,097	286	$432,080	117	$ 401,672
1907	939	342	5,231,215	385	646,575	229	1,560,802
1912	975	406	10,165,616	371	723,640	381	3,687,947
1917	943	404	18,546,504	363	614,678	423	4,965,566
1922	858	371	31,560,427	335	648,432	382	5,285,086
1927	682	238	39,124,811	277	775,008	312	4,270,662
1932	485	155	17,646,882	189	556,824	194	1,327,937

Source: U. S. Department of Commerce, Bureau of the Census, "Electric Railways and Motor Bus Operations of Affiliates and Successors," 1932.

Advantages and Disadvantages of Electric Railways in the Development of Freight Transportation.—In the development of freight transportation the electric railways labor under certain disadvantages in competition with other agencies, such as the steam railroads and motor-transport systems. The principal disadvantages may be summarized as follows:

1. The lack of industrial sidings and contacts with industrial concerns;
2. The lack of large and efficient freight terminals and terminal yards;
3. The lack of connection between electric lines and with the lines of other carriers;
4. The opposition on the part of municipalities to the operation of freight cars through city streets;
5. The inability of electric railway tracks to accommodate standard railroad freight-car equipment;
6. The abandonment of lines which has caused a shrinkage of electric railway mileage in recent years;
7. Restrictions in electric railway franchises which prevent the movement of freight at night;
8. The fact that the curves of electric railways are often too sharp, or the tracks are banked for fast passenger service and not adapted for the movement of freight; and
9. The lack of through rates and routes which often acts as a handicap in the solicitation of traffic.

On the other hand, electric railways possess certain competitive advantages, and in many cases they have developed coordinated services, which enable them to offer substantial competition to other carriers. In the first place, where no restrictions are imposed, freight can sometimes be handled at night when the lines would not otherwise be used. In the second place, electric railways often provide fast overnight schedules between important points, particularly for merchandise or package freight, which are attractive to shippers. In the third place, many electric railways have overcome the handicaps of lack of direct track connections with shippers and consignees by coordination of rail and motor-truck service. Several prominent electric railways collect and deliver shipments via motor truck and transport the freight over their rail lines between terminals. Sometimes cartage allowances or drayage-absorption arrangements are made which are attractive to shippers and consignees. "Ferry-truck" service, involving the use of trailers which are transported on the railway cars between terminals and hauled by tractors to and from the places of business of shippers and consignees, is offered by one prominent and progressive electric railway. Also, container services are sometimes provided. In

the fourth place, certain electric railways offer coordinated through service with steam railroad lines, with joint rates and through-billing arrangements. In a few cases interchange of equipment is effected between electric and steam railroad lines.

A survey of the electric railways which render freight services of various sorts indicates that nearly all handle both carload and less-than-carload freight. Only a few electric railways handle only carload freight. The distribution of the total amount of freight tonnage transported by electric railways between carload and less-than-carload freight shows that about 80 per cent is carload traffic, and about 20 per cent less-than-carload traffic. Among steam railroads the average traffic distribution is about 97½ per cent carload traffic, and 2½ per cent less-than-carload traffic.

Coordination of Electric Railway and Motor Freight Transportation.—The competition of motor trucks has compelled electric lines to establish coordinated electric railway–motor truck freight-transportation services. At the time of the organization of many of the electric railways in the United States, the highways were local affairs and relatively unimportant factors in the life of the various communities served by the electric lines. Horse-and-wagon transportation was slow and its radius of efficient activity was short. With the coming of the motor truck, however, the horse and wagon and the inadequate local or county roads were displaced with the result that the electric railways were confronted with increasingly severe motor-truck competition over improved state highways.

In the beginning the motor carriers were seldom regulated by public authority. Trucks competed with the electric railways and with each other, charging whatever rates would secure the traffic. Few of the motor operators kept sufficiently accurate or complete accounts to be able to determine whether or not they were actually operating at a profit or at a loss, and many of them remained in business only for a short time, although sufficiently long to injure the freight service of the electric lines. Motor-truck manufacturers often sold trucks on easy terms with relatively small first payments to present and prospective motor operators; while finance companies also assisted in bringing motor freight vehicles within the reach of many operators. The consequence was that, although failures were common and the

turnover rapid among truck operators, motor-truck competition continued to grow.

To meet this competition many electric lines operating freight services have coordinated motor truck and electric railway freight services. One of the spheres in which the motor truck has been of the greatest benefit has been in the terminal districts in large cities. Here motor trucks are used by the electric railways, as by the steam railroads, for the transfer of freight to off-line depots, or for store-door delivery service. The former use allows a railway which may have been deprived of an entrance to a centrally located freight terminal by franchise restrictions or by operating difficulties, to place a terminal in so central a location as to enable it to compete with all other transportation facilities serving the district. Store-door delivery and pickup services have been used to increase the attractiveness of electric railway freight services.

Several electric railways have established off-track stations in the centers of good traffic-producing sections of large cities. The freight is hauled between these stations and the railway terminals in outlying sections of the cities by motor trucks, or by tractors and semitrailers. The use of tractors and trailers permits the automotive units to be released while trailers are being loaded and unloaded.

Containers or demountable bodies are used by several electric railways to avoid the necessity of transferring freight in small lots from motor vehicles to electric railway cars at the outlying terminals. Hoisting equipment is used to lift the loaded containers or demountable bodies from the motor trucks to the electric railway freight cars or from the cars to the trucks. Motor trucks carry the containers between the stations of the electric railway lines and the places of business of shippers and consignees.

In performing the terminal freight services necessary to connect the lines of the electric railways with off-track stations in the important wholesale or retail districts of the cities served, or to connect the railways with the shipping platforms of shippers or consignees, many different arrangements are used. In some cases, the electric railways own and operate their own motor vehicles. In other cases, the motor vehicular equipment is owned and operated by subsidiary companies controlled by the

electric railways. In still other cases, arrangements are made with motor haulage companies or warehouse companies by the terms of which the haulage or warehouse companies act as agents of the electric railway companies. Sometimes joint-rate arrangements are made with haulage concerns, the motor freight carrier performing the terminal service and the electric railway the road-haul service, the carriers dividing the rates according to agreed divisions; and in other cases arrangements for terminal motor haulage are made by allowing shippers or consignees compensation from the electric railway rates for the haulage of the goods in the terminal areas, the allowances being paid either to the shippers or consignees or to their cartage agents. Since motor-truck lines usually give free pickup and delivery services, at least within defined free zones, it is necessary in such cases that the electric railways offer similar services. In cases where the electric railway freight rates are sufficiently low to permit, small charges are made for pickup and delivery services. A flat rate per hundred pounds is sometimes charged for either the pickup or delivery service in addition to the line-haul railway freight rate. Inner and outer pickup and delivery zones are sometimes established in the terminals, and lower charges are made for those services in the outlying districts. Freight is hauled between shipper and consignee warehouses in the outlying zones and the electric railway freight depots by motor truck, the line-haul service being performed by the electric railways.

A somewhat different plan of store-door service is performed by one electric railway in several of the towns along its interurban lines. The towns served by this carrier are strung along its tracks and the lines run on an important state highway. Many of the consignees and shippers are located on the streets of the various towns in which the line operates. The increase in volume of motor traffic on the narrow highways made it impracticable to stop the electric railway freight cars at each consignee's or shipper's place of business, since the cars often would have to be stopped several times in the same block for loading and unloading, this causing undue delay to street traffic and added congestion of the highways along the route. There were no suitable sites for centrally located freight stations available at reasonable prices in any of the towns, consequently, outlying freight stations were built by the electric railway and contracts were made with

local trucking companies to handle the collection and delivery services. The trucking companies were paid on a basis of a percentage of the freight rate in order to stimulate efforts in the solicitation of business.

A number of electric railways, in addition to using motor trucks in the terminal areas, have found trucks of great value in interurban freight-transportation services, enabling the electric lines to handle freight economically in small lots, without restricting their truck capacity for other services. The intercity use of freight trucks by electric railways has been confined for the most part to the extension of the service of the railways into territories not reached directly by their rails. Electric railway companies do not as a rule operate the intercity freight trucks themselves, although they sometimes operate intercity passenger buses. Freight services are usually provided by interline agreements for through billing and through rates between the electric railway and motor freight lines. Contracts are often made by the electric railway lines with independent motor-truck operators to give through service to towns beyond the lines of the electric railways.

Electric railways have gone far in recognizing the motor truck as a new facility in freight transportation and, in the absorption of motor freight service into their operations, they have outstripped the steam railroads of this country. Electric lines are using motor trucks to their advantage and profit and to the improvement of their transportation services. However, the coordination of electric railway and motor transportation has been mutually beneficial. The motor truck has done much to improve the service and the financial position of many electric railway properties, but the electric railways in turn have contributed much to the standardization and stabilization of the motor freight-transportation industry.

Traffic Practices.—The traffic departments of electric railways seek to develop traffic through the personal solicitation of shippers and consignees by traffic officials or representatives, by the soliciting efforts of the local agents of the lines, by car-card advertising, by the posting of freight schedules and rate-publicity notices in their stations, by newspaper and trade-paper advertising, by radio publicity, and by representation at conventions and other meetings where prospective patrons are present. Good service and attractive rates in the electric railway business,

as well as in other forms of transportation, are, of course, the most effective means of traffic development.

Joint arrangements for the transportation of through traffic are maintained by electric railways in a great variety of ways:

1. Joint arrangements with steam railroads at joint through rates, through billing, and audit settlements of the proceeds due each carrier;
2. Joint-service arrangements without through joint rates, each carrier using its own local or proportional rates;
3. Joint arrangements either with or without joint through rates, billing, and settlements with other electric railway lines;
4. Joint arrangements either with or without rate, billing, and settlement arrangements with water carriers; and
5. Joint arrangements either with or without rate, billing, and settlement arrangements, or agency arrangements with motor freight carriers.

In addition to regular carload or less-than-carload freight traffic, many electric railways have sought to develop special types of traffic, such as mail and newspapers, express, baggage, milk and dairy products. Some of the larger systems have gone extensively into the development of industrial traffic by organizing industrial departments which furnish information with respect to manufacturing and other business sites, the availability of materials and supplies, labor and housing conditions, tax rates, water supply, markets, and other conditions along their lines. Others have sought to develop the movement of farm products directly to city markets, and to develop the agricultural resources of the territories served by the lines. In some cases the electric railways furnish rolling-stock equipment for demonstration trains operated in cooperation with agricultural colleges or universities to instruct farmers in scientific agricultural methods, and model farms are sometimes operated along the lines where inspections and meetings are held to encourage better agricultural methods. Agricultural experts are sometimes employed by the electric railways to assist farmers along the lines to increase the productivity of their farms or animals; meetings of farmers are arranged for lectures on farm topics; and cooperative growers' associations are sometimes promoted to assist the farmers along the routes of the electric lines to market their products to better advantage. Electric railway employees are encouraged to join

Granges or other organizations of farmers, and generally to cooperate with farmers in their collective efforts to improve the conditions of agriculture in the districts served. Thus in all important respects the activities of the larger freight-carrying interurban electric railway systems are similar to those of the steam railroads.

Freight Rates.—The freight transported by electric railways is usually classified for rate-making purposes upon the basis of the Official, Southern, or Western classifications used by the steam railroads in the respective districts in which the electric railways operate. A few electric railways engaged solely in intrastate commerce use the intrastate freight classifications applicable in the states in which they operate, or use their own systems of classification, if no such intrastate classifications are applicable.

The freight rates of the electric railways are constructed in much the same ways as steam railroad freight rates in the same districts, except that in order to attract traffic the electric railway rates are usually somewhat lower than the corresponding steam railroad freight rates. There is no uniform differential rate relationship between steam and electric railway freight rates. The policy of many electric railways is to establish freight rates almost solely with reference to the rates of competitive carriers. In some cases, rates are reduced by a fixed number of cents per one hundred pounds below the steam railroad rates, in other cases a percentage differential is used. In all cases the rates are reduced by amounts deemed by the electric railway traffic officers sufficient to meet competition. Similarly, rates are often established on a basis which will enable the electric railways to meet motor competition.

The freight rates of the electric railways are published by the carriers either in individual tariffs of the carriers or in agency tariffs published for the accounts of a number of participating electric railway carriers by the tariff-publishing agent of an electric railway traffic association. In some cases, electric railways participate in railroad or motor-truck tariff-publishing organizations in order to bring their freight-transportation services in direct competition with these services. A typical electric railway freight tariff publishing interstate and intrastate freight rates contains local and proportional class, commodity and

distance rates. The tariff is issued by the general freight agent of the company, and is filed with the state public service commission and with the Interstate Commerce Commission.

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CHAPTER X

PIPE LINE TRANSPORTATION

The petroleum industry may be divided into four major divisions: production, transportation, refining, and distribution. These divisions are not separate and distinct when the companies are considered, since many engage in operations included in two or more of these major divisions; yet the above divisions will be useful for our purposes. Transportation is a vital part of the

TABLE 31.—PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES
(In thousands of barrels of 42 U. S. gallons)

Year	Amount	Year	Amount
1857–1860	502	1920	442,929
1865	2,498	1925	763,743
1870	5,261	1926	770,874
1875	8,788	1927	901,129
1880	26,286	1928	901,474
1885	21,859	1929	1,007,323
1890	45,824	1930	898,011
1895	52,892	1931	851,081
1900	63,621	1932	781,845
1905	134,717	1933	905,656
1910	209,557	1934	908,065
1915	281,104		

Source: U. S. Bureau of Mines.

process by which petroleum is taken from the soil and made available to ultimate consumers, but the transportation problem is so inseparably connected with production and refining problems that a brief consideration of some of the latter is necessary to give the reader a proper perspective as to the former.

Production of crude petroleum in the United States (see Table 31) has grown from 502,000 barrels in the period from 1857 to 1860 to a peak of 1,007,323,000 barrels in 1929. Just as significant as the growth in total production from the viewpoint

of transportation are the locations of production, refining and consumption areas, and changes which have taken place in these locations in the course of the past 30 years. Up to 1901, only 40,000,000 barrels of crude oil, 4 per cent of the total produced in the United States until that year, had been produced west of the Mississippi River, 1,033,000,000 barrels, or 96 per cent, having been produced east of that river. In 1901, with the discovery of much oil in the Mid-Continent and in the Gulf Coast regions, the situation changed materially. In that year of a total of 69,000,000 barrels produced in the United States, 55,000,000 barrels, or 80 per cent, was produced east of the Mississippi and 14,000,000 barrels, or 20 per cent, west. The shift in production has been steadily westward since that time. In 1930, only 5 per cent of the total production of the United States came from regions east of the Mississippi, 95 per cent being produced west of that river. From the beginning of the oil industry, about 1859, until the end of 1930, of a little more than 12,000,000,000 barrels of crude oil produced in the United States, 87 per cent was produced west of the Mississippi and only 13 per cent east. The principal producing state east of the Mississippi has been Pennsylvania, with about 841,000,000 barrels total production in 70 years. During the 30 years, 1901 to 1930, Oklahoma produced nearly 3 billions of barrels; Texas more than 2¼ billions and California, almost 3½ billions. These three states today produce more than 80 per cent of all the crude oil produced annually in the United States.[1]

There are at present in the United States eight major producing districts for crude petroleum: The Appalachian district, which may be divided into two parts, the first including the states of New York, Pennsylvania, Ohio, and West Virginia, and the second including the states of Kentucky and Tennessee; the Lima, northeastern Indiana and Michigan, district; the Illinois and southwestern Indiana district; the Mid-Continent district, including the states of Kansas, Oklahoma, Texas, Arkansas, northern Louisiana, and southeastern New Mexico; the Gulf Coast district, including southeastern Texas and the southern part of Louisiana; the Rocky Mountain district, including the states of Montana, Wyoming, Utah, and Colorado; and the

[1] Statement of Charles E. Bowles, hearings on H. R. 16695, 71st Cong., 3d Sess., pp. 11, 12, 13.

California district. Crude-petroleum production by districts for 1933 and 1934 is given in Table 32.

TABLE 32.—PRODUCTION OF CRUDE PETROLEUM BY FIELDS
(In thousands of barrels of 42 U. S. gallons)

Field	1933		1934	
	Production	Percentage of total U. S.	Production	Percentage of total U. S.
Appalachian:				
Pennsylvania grade....... .	21,197	2.3	23,958	2.6
Other (incl. Kentucky).	6,239	0.7	6,547	0.7
Lima: N.E. Ind., Mich........ ...	8,988	1.0	11,603	1.3
Ill., S.W. Ind............... .	4,967	0.5	5,293	0.6
Mid-Continent:				
N. La. and Ark......... . .	21,555	2.4	20,257	2.2
West Texas, S.E. New Mexico	69,092	7.6	66,760	7.3
East Texas.................	204,954	22.7	181,540	20.0
Other (Okla., Kans., N. Texas, etc.)................. ...	305,546	33.8	316,175	34.8
Gulf Coast...........	76,308	8.4	83,949	9.3
Rocky Mountain..	14,800	1.6	17,678	2.0
California....................	172,010	19.0	174,305	19.2
Total...	905,656	100.0	908,065	100.0

Source: U. S. Bureau of Mines.

Prior to 1876 crude oil was refined almost entirely in the neighborhood of the wells, but after this, refineries were located near large consuming markets, such as Cleveland, Pittsburgh, Buffalo, Baltimore, Philadelphia, and New York. Early refineries were located near the oil wells principally because the crude oil could be used for fuel and power in refining operations, and so that the waste products in the petroleum would not be transported. A considerable part of refining still takes place near the sources of crude oil, but since 1876, and especially since 1920, significant changes have taken place in the location of refineries, due principally to the development and the cheapness of pipe line transportation of crude petroleum.

In 1920, about 51 per cent of the refining capacity of the United States was located inland and near oil-producing areas, as com-

pared with 49 per cent in coastal areas and near market centers; but in January, 1931, 67.3 per cent was located in coastal areas and near market centers, and only 32.7 per cent inland near the oil-producing regions. Note the changes in the Mid-Continent area, for example. In 1918, this area had 27.9 per cent of the total refining capacity of the United States, but in January, 1931, this proportion had dwindled to 22.8 per cent, and this in spite of the huge volume increase in crude production in that area from 277,793,000 barrels in 1920 to 642,014,000 barrels in 1929. The principal reasons for this shift in refinery location are the cheapness of pipe line transportation of crude oil, and the nearness of refineries to markets for their product.[1]

The bulk of crude-petroleum shipment takes place between the Mid-Continent fields and the refineries east of the Mississippi. In 1930, for example, there were run to stills east of the Mississippi River about 313,000,000 barrels of oil. Of this amount, 47,000,000 barrels were produced east of the Mississippi, and 57,000,000 barrels represented foreign crude. The balance was transported from the Mid-Continent fields, except for a small amount drawn from storage.[2] Part of the shipment went by pipe line, part by tank steamer. Shipments from the lower part of the Mid-Continent fields generally go by pipe line to the Gulf Coast and thence to the Atlantic seaboard by tank steamers. Shipments of crude petroleum from California to the Atlantic seaboard by way of the Panama Canal, which were of considerable volume in 1923 and 1924, have declined to relatively small volume.

Development of Pipe Line Transportation.—The first successful attempt to pipe oil any considerable distance without leakage was accomplished in western Pennsylvania by Samuel Van Syckel, in 1865. This was a 2-in. line, 4½ miles long, extending from the Pithole field to the terminus of the Oil Creek Railroad at Miller's farm. A few earlier attempts had been made but were not successful. One of these, a 3-mile line up Oil Creek to Miller's farm, laid in 1863, was used for a time, but the line was made of cast-iron pipe with lead joints and the pressure from the pumping blew out the lead from the joints with con-

[1] PETTY, E. C., "Developments in the Petroleum Refining Industry as Related to Overproduction of Crude Oil," pp. 23–24, University of Oklahoma Press, Norman, 1932.

[2] Statement of Charles E. Bowles, *op. cit.*, p. 14.

sequent wastage of oil. The line from the Pithole field was an immediate success, a pipage charge of $1 per barrel being assessed for the service, as compared with rates as high as $3 per barrel charged by teamsters who up to that time transported crude oil from these fields to various points in Oil Creek. The teamsters who thus saw their livelihood being threatened tore up the line in various places and the company was compelled to appeal to the sheriff to keep it in operation.

The demonstration of the practicability of pipe line transportation of crude petroleum led to the development of many short lines and within a few years practically all the producing districts in the Appalachian fields were connected by pipe lines with near-by refineries or with railroads which then completed the haul to more distant refineries. In 1875, a 4-in. line, 60 miles long, was laid from the Titusville fields to Pittsburgh, and this was followed by a line 5 and 6 in. in diameter, 111 miles long, from Bear Creek to Cleveland, Ohio, but construction of through pipe lines to tidewater did not come until 1879. In that year the Tidewater Pipe Company laid a pipe line from the oil fields in northwestern Pennsylvania to the seaboard. This was followed by many other long-distance lines and gradually the bulk of crude oil came to be transported by pipe line. By 1892, numerous pipe lines aggregating 3,000 miles in length connected the oil pools of western Pennsylvania with refineries located in the larger cities of Ohio, Pennsylvania, Maryland, New Jersey, and New York.

The economy of pipe line transportation was established long before crude oil was discovered in the Mid-Continent area, and the development of pipe lines leading from this field began when substantial production had been obtained in southwestern Kansas and northeastern Oklahoma. This network has grown rapidly and has produced the giants of the petroleum pipe line transportation systems. There is now a continuous connecting system of trunk lines from the Mid-Continent fields in Kansas, Oklahoma, and Texas to Baltimore, Philadelphia, and New York. In addition, pipe lines extend from these fields as well as from those in the Gulf Coast district southward to points on the Gulf of Mexico, from which points crude oil is shipped in considerable volume to refineries along the Atlantic seaboard. Others extend northward to Kansas City, St. Louis, and Chicago.

According to the Bureau of Mines, there were on May 1, 1932, 58,020 miles of oil trunk lines in the United States, and 53,640 miles of oil-gathering lines, a total of 111,660 miles.[1]

Gasoline Pipe Line Transportation.—Until 1931, oil pipe lines had been constructed almost wholly for the transportation of crude oil, but during that year extensive developments in the transportation of gasoline by pipe line took place. The Texas Panhandle region was connected with St. Louis, Missouri; the Oklahoma and Kansas refining centers were connected with Chicago, St. Paul, and marketing centers en route; and Marcus Hook, Pennsylvania, was connected with Syracuse, Pittsburgh, and Cleveland. One of the longest gasoline pipe lines is that of the Great Lakes Pipe Line Company, 1,400 miles long, of 4-, 6-, and 8-in. pipe, with a capacity of some 30,000 barrels a day. It is owned jointly by the Continental Oil Company, the Barnsdall Oil Corporation, the Skelly Oil Company, the Mid-Continent Petroleum Corporation, and the Phillips Petroleum Company. It extends from Ponca City, Oklahoma, to Chicago and the "Twin Cities," via Barnsdall, Kansas City, and Des Moines, with an extension to Omaha, Nebraska. Besides the gasoline lines in the Mid-Continent and eastern areas, there are several major gasoline trunk lines in California aggregating some 260 miles.

While the transportation of gasoline through pipe lines is a new development, it is one that promises considerable expansion. Substantial savings are effected in carrying charges as well as in losses from evaporation. It is of great importance to inland or oil-field refiners, these being at a serious disadvantage with refiners in large population centers who ship crude to their refineries by pipe line. At present there are some 4,000 miles of gasoline pipe lines in the United States.[2]

Organization of the Industry.—A pipe line system is not merely a line of pipe. It consists of the whole plant employed in the process of transportation, including initial, intermediate, and terminal tankage systems, power plants, pumping stations, systems of communication along the line, and all other facilities necessary to transport oil from one point to another safely and

[1] Report on Oil Pipe Lines, House Report 2192, 72d Cong., 2d Sess., p. xxvii.

[2] WALKER, P. A., History of Pipe Line Transportation, Associated Traffic Clubs *Bulletin*, Nov. 10, 1931, p. 82.

expeditiously. Individual producers, of whom there are many thousands, generally sell their product outright either to a pipe line company or to some large refiner having transportation and storage facilities. Few producers have either the capital or sufficiently large producing properties to warrant the construction of pipe lines, and wide fluctuations between production and consumption have necessitated the erection of great reservoirs where oil from hundreds of wells may be stored until demanded.

Oil from the well is run directly into well storage where it is allowed to settle so as to remove water and sand. Sometimes special treatment is necessary to separate the water before the oil is ready for sale. In many cases when a well is first brought in, especially at a distance from a tank farm or pipe line connection, and it must be stored at the well, only large earth pits or reservoirs are dug. In this way much oil is lost through seepage and evaporation before it is transported. Other losses occur in transportation and storage in the tank farms. A study made by the Bureau of Mines, in 1918, showed that Mid-Continent crude suffered a loss of over 6 per cent by volume before it was delivered to the refiner. In recent years the use of steel tanks has reduced such losses materially.[1]

Formerly the oil was shipped by rail from the field storage to the refineries, these being built as close as possible to large producing areas to avoid transportation charges. Today, however, practically all producing areas are connected by gathering pipe lines which carry the oil to the main trunk lines and thence to tank farms where it is stored. In a few cases, where refiners desire the oil from particular wells, shipment is still made by rail to the refinery, but in 1929, according to estimates of the Department of Commerce, only 0.6 per cent of the crude oil was transported from the wells by transportation agencies other than pipe lines.[2] From the tank farms of the pipe line company the oil is transported to refiners as demanded. Those refiners who either do not own oil-producing wells, or do not own a sufficient number to supply their full requirements, buy crude from the pipe line companies. Pipe lines vary from 2 to 12 in. in diameter, trunk lines usually being 8 to 12 in., and gathering lines less than 6 in. in diameter, although much

[1] U. S. Bureau of Mines, Oil Storage Tanks and Reservoirs, *Bulletin* 155.

[2] U. S. Department of Commerce, Domestic Commerce Series, *Bulletin* 44, p. 106.

6- or 8-in. pipe is found in what might be called gathering systems. There has been a tendency towards the use of larger pipe, due in part to the fact that the carrying capacity of a pipe at equal pressures increases faster, owing to a decrease in the amount of friction as the diameter increases, than the square of the diameter, which determines the cubic capacity of the pipe line.

The crude oil transported by pipe lines is gathered from many wells and in general practice no attempt is made to retain the identity of original shipments. Because of this practice and the fact already mentioned, that few producers are able to provide storage and transportation facilities, it has long been the custom for the pipe line companies to purchase the crude from producers and sell it to refiners. Add to this the further fact that for long-distance transportation of crude oil, the pipe line has no competitor, save the tanker where feasible, and it can be readily seen that those who control the pipe lines in turn control the price of crude oil. During early years, especially in Pennsylvania, crude oil was bought and sold through the medium of pipe line certificates issued by the pipe line companies after the crude was run into their gathering lines, but in 1895 this method was changed. In that year the Seep Purchasing Agency of Oil City, Pennsylvania, on behalf of the Standard Oil Company, gave notice that after Jan. 23, 1895, the prices it would pay to oil producers would be announced, or "posted" by it. This inaugurated the practice of "posting prices" for crude oil which is in vogue today.

There were several reasons why the Standard Oil Company was able to introduce the practice of posting prices. In the first place, through the Seep Agency, it then purchased 80 per cent of the crude produced in Pennsylvania and Ohio. In the second place, it controlled practically all the pipe line mileage, the only competitor being the Pure Oil Company, with a line from the Appalachian fields to Marcus Hook, Pennsylvania. In 1904, according to a report of the Commissioner of Corporations, the Standard Oil Company and affiliated concerns, although they produced not more than one-sixth of the total crude production, transported through pipe lines nearly nine-tenths of the crude from the older fields, and 98 per cent of the crude from the Mid-Continent area. They refined over 84 per cent of the total crude run to refineries, and produced over

86 per cent of the total illuminating oil, the principal product of refining in those days. The growth and power of the Standard Oil and affiliated concerns, the Commissioner said, rested primarily upon the control of transportation facilities in one form or another.[1]

The situation with regard to control of crude-petroleum prices by the Standard companies has changed materially since that time, but the bulk of crude petroleum today is sold at "posted" prices. In California and in the Rocky Mountain fields some is sold by contract, and in the Appalachian fields, although the bulk is sold at posted prices, producers usually have the option of running the crude to storage and receiving pipe line certificates when delivered to the pipe line companies. In 1928, there were 10 important crude-purchasing companies belonging to the Standard group, 7 large independents, and a number of smaller ones that regularly posted prices for crude oil. In certain oil fields, such as the Appalachian and the Rocky Mountain, there are only a few purchasers. In others, particularly the Mid-Continent and Gulf Coast fields, there are many. In many cases, the crude-purchasing companies are pipe line companies; in others, refiners; and in still others, they are parts of closely related, integrated systems.[2]

The Control of Pipe Lines.—There is a high degree of concentration in the ownership of oil and gasoline pipe lines which reflects the concentration which is found in the oil industry itself. For the most part, pipe lines are integrated with other branches of the petroleum industry. Regarding this integration the House Committee on Interstate and Foreign Commerce, in a recent report to Congress, had this to say:

Generally speaking, the oil industry is organized on the basis of assigning a single function to each of the companies making up an integrated group. Thus there are many subsidiaries which produce oil but do not transport or refine it or sell its products, as well as many other companies which do only refining or only marketing or furnish only transportation services. Particularly numerous are the marketing companies. Where the operations of a single company reflect what

[1] Commissioner of Corporations, "Report on the Petroleum Industry," 1907.

[2] Federal Trade Commission, "The Petroleum Industry," Senate Doc. 61, 70th Cong., 1st Sess., pp. 99–107.

might be termed one or more degrees of vertical integration, the most common combination of functions is that of refining with marketing. Such companies purchase their oil from other companies of the group or from the outside, refine it and market it. Some 13 cases of this kind have been found, including one in which marine equipment is also operated. Of these 13 companies 6 have subsidiaries, mainly engaged in marketing operations.

There are 9 cases in which the production of crude oil is added to refining and marketing operations, in 5 of which there are subsidiaries. Instances of substantially complete integration of operations from the oil field to the retail service station number 11; 7 of these companies have subsidiaries. Aside from these major groupings are cases, numbering 4, in which the operation of pipe lines is combined with refining and marketing; in 3 of these cases the pipe lines are used to bring crude oil purchased or produced to the refinery and in 1 case they are used in the distribution of refined products; 2 cases where refining and pipe line operations are combined; 1 case where oil is produced, transported, and refined but marketed by other companies; and 2 cases where oil is produced and refined but not transported or its products marketed. Pipe lines are also owned by 1 company engaged only in oil production, by 1 company purchasing oil, and by 1 company distributing crude oil. There are a few miscellaneous groupings of functions.[1]

The above summary shows not only the high degree of integration which characterizes the oil industry, but that combined action is commonly attained through numerous subsidiaries on the basis of widespread purchase and sale arrangements. There are only 11 cases of complete integration, and most of the subsidiaries have only one or two functions. The House committee classified companies owning pipe lines into three classes: large and medium-sized integrated units of the oil industry; partially integrated and smaller integrated units; and independent pipe lines. A comparison of the sizes of these three groups is shown in Table 33. The companies included in this study own 94.7 per cent of the total oil pipe line mileage of the United States.

The further concentration of the oil business in the hands of a relatively small number of companies is shown by an inspection of the companies in the first or major group. Two companies—Standard Oil Company of New Jersey and Consolidated Oil Corporation—own 30 per cent of the group investment in pipe

[1] Report on Pipe Lines, House Report 2192, 72d Cong., 2d Sess., pp. xliii–xliv.

TABLE 33.—COMPARATIVE SIZE OF THREE GROUPS OF COMPANIES

Basis of comparison	Large and medium-sized units of oil industry		Partially integrated and smaller units of oil industry		Independent pipe lines		Total	
	Amount	Per cent of total	Amount	Per cent of total	Amount	Per cent of total	Amount	Per-centage of total
Capitalization of top companies...	$5,265,071,186	96.43	$163,444,205	2.99	$31,760,000	0.58	$5,460,275,391	100.00
Gross investment in pipe lines*....	$ 939,378,543	92.62	$ 17,808,572	1.75	$57,094,879	5.63	$1,014,281,994	100.00
Mileage of pipe lines:†								
Oil	82,508.46	78.00	3,697.68	3.50	19,531.98	18.50	105,738.12	100 00
Gasoline....................	3,874.17	100.00	....	.....	....	.....	3,874.17	100.00
Total mileage.............	86,382.63	78.81	3,697.68	3 37	19,531.98	17.82	109,612.29	100.00
Refining capacity daily (barrels)‡	2,826,900	95.8	122,080	4.2	....	.....	2,948,980	100.00

* Approximate.

† Includes that part of mileage of Stanolind Pipe Line Company which is leased at present for transportation of natural gas.

‡ Compiled from "Petroleum Refineries in the United States, Jan. 1, 1932," by G. R. Hopkins and E. W. Cochrane, Department of Commerce, Bureau of Mines.

Source: Report on Pipe Lines, House Report 2192, 72d Cong., 2d Sess., p. xxvii.

line facilities; these companies and the next two largest ones—Standard Oil Company of Indiana and Socony-Vacuum Corporation—account for one-half of the total. Other companies having investments in pipe lines in excess of $50,000,000 are Gulf Oil Corporation of Pennsylvania, the Texas Corporation, and the Shell Union Oil Corporation. Together these companies account for more than 73 per cent of the group investment in pipe lines, the group as a whole owning all the gasoline pipe line mileage and 78 per cent of the oil pipe line mileage of the United States.[1] Still further concentration is noted in the ownership of the top companies. In several control is vested in one family through stock ownership; in several other cases a substantial part of the voting power is held by a single interest or related group of interests; and in other cases, although there is a wide diversification of stock ownership so that no individual or clearly defined group holds a substantial amount of the stock, the management perpetuates itself by soliciting proxies and by endeavoring so to conduct the affairs of the company as not to give rise to formidable opposing groups.

Pipe Line Transportation Costs.—There are three general characteristics of the costs of pipe line transportation of petroleum which are significant. In the first place, total costs vary considerably with the different conditions under which construction and operation take place. In the second place, total costs are relatively large so that pipe line transportation over long distances is essentially a large-scale enterprise. In the third place, there is a tendency for total costs per unit to decrease up to the full utilization of plant and equipment.

The variations which occur in pipe line costs are due primarily to variations in the amount of investment necessary under different conditions. There are substantial variations in operating costs, but these costs do not constitute so important an element in total costs as do investment costs. A principal element in investment costs consists of those costs incurred in the laying of the pipe itself—the cost of the pipe and fittings, permanent leases and rights of way, and the actual construction. These costs are increased materially, however, by the necessity of providing pumping stations, storage, and communication facilities. In general, the cost of constructing a pipe line of

[1] *Op. cit.*, p. xxviii.

given capacity varies according to the distance which the pipe has to be transported from the place of manufacture, the topographical conditions under which it is laid, the value of the land used for right of way, the wages of labor, and many other factors. Manifestly it costs more to construct a pipe line in a mountainous country remote from centers of manufacture, requiring more or less excavation of solid rock, than in a level country near the centers of manufacture and where all conditions are favorable. The cost of pumping stations varies with the amount of business which they must handle, and the necessary provision of power, water, and other supplies. On account of variations in these factors pumping stations are not always located equal distances apart or at such points as would result in equal pressure on the pipes under normal operation. To overcome this disparity certain stations may operate at higher pressure than others, or the friction may be reduced by putting in larger pipe over part or all of the distance between two stations, or the lines may be looped to equalize the pressure. Pumping stations are located at intervals of about 35 to 40 miles in the East and the Middle West, and sometimes at greater distances. In California, however, due to the heavier nature of the crude, the average distance between stations is about 12 miles. Another fact which adds to the cost of transporting California crude is that it must be heated to obtain the proper viscosity. Other elements in investment costs are the cost of communication and storage facilities, the latter constituting an important item. In 1926, it was believed that it cost about 20 cents a barrel annually to store crude oil of average gravity at prices then prevailing.[1]

The figures available give only a rough estimate of the total costs of pipe line transportation, but they are sufficiently accurate and complete to indicate the large-scale nature of the enterprise. A study made by the Federal Trade Commission, in 1916, showed the average cost of building and equipping an 8-in. pipe line from the Mid-Continent fields, based upon the cost of constructing 2,200 miles of 8-in. lines by six different companies, to be approximately $9,000 per mile.[2]

[1] U. S. Department of Commerce, Domestic Commerce Series, *Bulletin* 44, p. 121.

[2] Federal Trade Commission, "Pipe Line Transportation of Petroleum," Letter of Submittal, 1916, p. ix.

The 51 pipe line companies which reported to the Interstate Commerce Commission in 1931, which owned 93,090 miles of trunk and gathering lines, reported investments in pipe lines totaling $845,049,923, or $9,077 per mile. On the basis of these figures, therefore, the cost of an 8-in. line from the oil fields of Oklahoma to the Gulf Coast would be roughly $4,500,000; to Chicago, about $6,000,000; and to the Atlantic seaboard, about $13,500,000. The carrying capacity of a pipe line varies with the size of the pipe, the distance between pumping stations, the pressure at which the oil is pumped, and the viscosity of the oil. However, the daily capacity of an 8-in. pipe line, operating at a pressure of 800 lb. per square inch and transporting oil at 38 degrees Baumé gravity, is 21,000 barrels.[1]

In other sections of the country the costs per mile are often much greater than in the Mid-Continent area. The Shell Union Oil Corporation's trunk line in California, constructed in 1913, aggregating 170 miles, cost on the average $16,800 per mile, due to the heavier character of California crude which necessitates the construction of special heating plants and the location of pumping stations at closer intervals.[2]

The tendency towards decreasing costs is due to the fact that certain costs are relatively fixed in amount regardless of the amount of oil transported through the pipe line system. Among these are construction costs, depreciation, and certain operating expenses, like maintenance, superintendence, ground rent, and most of the general expenses. A large part of pipe line transportation costs, therefore, are largely independent of the volume of traffic; consequently, unit costs tend to decrease with increase in the volume of oil transported up to the capacity of the plant and equipment.

The House committee, in its recent report, found that the factors entering into transportation costs have materially changed in recent years, particularly with the development of pipe lines suited to the transportation of gasoline and other refined products and of more economical methods of pipe line construction. Accordingly, companies whose transportation

[1] Pogue, J. E., "The Economics of Petroleum," pp. 66–67, John Wiley & Sons, Inc., New York, 1921.

[2] Stocking, G. W., "The Oil Industry and the Competitive System," p. 215, Houghton Mifflin Company, Boston, 1925.

program was based on earlier cost factors have had to effect readjustments to the changed situation. This they have done by relocating their refineries or changing their refinery schedules, by constructing gasoline lines, or by converting oil lines to gasoline lines, or otherwise. In general it may be said that pipe line transportation costs per barrel are lower than those for any rival transportation agency except the tanker.

Use of Pipe Lines by Outside Shippers.—Oil pipe lines are for the most part plant facilities in an integrated industry. The House committee summarized outside shipments by companies owning pipe lines for the three groups into which it classified the companies—Group 1, large and medium-sized units of the oil industry; Group 2, partially integrated and smaller units of the oil industry; and Group 3, independent pipe lines—as follows:

It will be noted that over 60 per cent of the companies in Group 1 reported that in 1931 they carried no outside oil in their gathering lines and that about 50 per cent of such companies made a similar report on the use of their trunk lines. Only 5.1 per cent of the gathering lines were reported to have carried in excess of 50 per cent of outside oil and only 10 per cent of the trunk lines. Passing over the intermediate group of companies to the third, a marked contrast is to be noted. As required by the circumstances of their operations, nearly all of the important lines in this group report a 100 per cent movement of "outside" oil.

Also of interest is the number of outside customers served. In the case of the gathering lines, the number in 1931 ranged from 1 to 11,813. Of the companies reporting, 9 had 1 or 2 outside customers, 6 from 3 to 9, 4 from 12 to 34, and 3 from 100 to approximately 400; the remaining 5 cases are as follows: Illinois Pipe Line, 2,696; Southwest Pennsylvania Pipe Lines, 3,019; National Transit Company, 5,794; Eureka Pipe Line Company, 8,539; and Buckeye Pipe Line Company, 11,813. The number of outside trunk-line customers of these companies were respectively 5, 6, 20, 9, and 63, indicating that the oil had passed into relatively few hands before receiving trunk-line movement. Four of these five companies, and, in fact, all except two of the companies having in excess of 34 customers fall in the group of independent pipe lines.

Outside trunk-line customers numbered 1 or 2 in the case of 10 companies and ranged from 3 to 10 in the case of 15 companies. The remaining cases are as follows: Indiana Pipe Line, 16; National Transit Company, 20; Gulf Pipe Line Company of Oklahoma, and Gulf Pipe Line Company of Pennsylvania, 23 each; Texas Pipe Line Company,

29; Gulf Pipe Line, 32; Pure Oil Pipe Line Company of Texas, 36; and Buckeye Pipe Line Company, 63. While only 3 of these 8 companies are members of the independent group, in each of the 3 cases all oil carried was outside oil, while the percentage of outside oil carried by the 5 remaining companies ranged from 5.1 to 100 per cent.

The foregoing summary of the number of outside customers indicates that in the main the oil carried in gathering lines passes into relatively few hands before it is tendered to such lines and that there is further concentration of ownership of the oil when it is ready for trunk-line movement. Outside shippers are therefore generally large shippers, representing other units of integrated or partially integrated oil groups.[1]

Pipe Line Rates.—Rates for the interstate transportation of oil by pipe line are subject to regulation by the Interstate Commerce Commission, and for intrastate transportation by state commissions, but in many cases no tariffs are filed. Of 40 companies engaged in gathering oil, 25 file no tariffs. Some of these companies carry only oil produced by them, others only oil purchased by them, and others both produce and purchase oil. Of 32 companies whose trunk lines carried only company oil in 1931, 17 file no tariffs. In some cases tariffs are filed but no outside oil or gasoline is offered for shipment. In still other cases joint construction or joint ownership of lines reflects a tendency to provide facilities which one or more of the parties would have had to hire at going rates had there not been a participation in ownership. In general the rates filed are artificially constructed and bear little relation to transportation costs.[2] The rates are divided into trunk-line and gathering charges. Gathering charges formerly were on a flat basis, whether the transportation was for 1 mile or for 50 miles, but there has been some tendency towards a mileage basis. Trunk-line rates vary roughly with distance, and in some instances with the number of pumpings required and the character of the terrain which the lines cross, thus reflecting cost factors. In many cases they are held down by rates on competitive routes. They are usually group rates, many producing and consuming areas having the same rates. Minimum-tender requirements for interstate shipment cover a wide range. The most common requirement is 100,000 barrels, and the second most common,

[1] Report on Pipe Lines, *op. cit.*, pp. lxiii–lxiv.

[2] Federal Trade Commission, "The Petroleum Industry," Senate Doc. 61, 70th Cong., 1st Sess., p. 38.

25,000 barrels. Some interstate minima range down to and even below 10,000 barrels. In many instances a pipe line is governed by the requirements of its connections. There are substantially no minimum-tender requirements attaching to the use of gathering lines.

Regulation of Pipe Line Transportation.—The comparative cheapness of pipe line transportation of crude oil which has made possible its economical transportation over great distances has led to the creation of a network of pipe lines which present transportation problems similar to those of railroad transportation. Carriers of petroleum by pipe line were subject to practically no regulation prior to 1906, but in that year with the passage of the Hepburn Amendment to the Interstate Commerce Act, there was placed upon pipe line companies the obligations of common carriers and they were subjected to regulation by the Interstate Commerce Commission. The reasons for inserting in the Hepburn Amendment the section applying to pipe lines were these: The Standard Oil Company had obtained control of practically all the pipe lines connecting the different producing fields east of California with refining centers. Availing itself of its control of the pipe lines, this company and its subordinates refused to carry any oil through its lines unless the same was sold to it or to its subordinates. In this way it controlled practically the whole petroleum industry; for as we have seen, rail transportation could not compete with pipe line transportation over any but short distances, and a producer without pipe line connection could not ship his oil. Neither could a refiner afford to purchase crude at prices sufficient to cover rail transportation costs, except in the case of special crudes, or crude oil carried only short distances. The object of the amendment was to require pipe line companies to transport oil for all applicants at reasonable rates and under reasonable conditions so as to enable producers and refiners to carry on operations free from control by the Standard Oil interests.

Pursuant to this enactment of Congress, the Interstate Commerce Commission issued an order requiring pipe line companies to file with it schedules of their rates and charges for the interstate transportation of oil. This order was contested by the pipe line companies and a preliminary injunction was granted by the Commerce Court, in 1913, on the grounds that the pipe

lines were private carriers, that the act to regulate interstate commerce applied to every pipe line that crosses a state boundary, and that thus construed, it was unconstitutional.[1] The following year, however, the Supreme Court of the United States set aside this decree of the Commerce Court, holding that pipe lines were common carriers and as such were subject to Federal regulation. The only exception made was where a company was drawing oil from its own wells across a state line to its own refinery for its own use.[2]

In spite of this decision of the Supreme Court there was little use of pipe lines as common carriers until action was taken by the Interstate Commerce Commission in 1922. Pipe line companies, not desirous of transporting oil for all parties evaded their common-carrier obligations by charging high rates and requiring excessively large minimum shipments of oil. Pipe line tariffs governing shipments from the Mid-Continent fields contained requirements of minimum quantities for single shipments ranging from 25,000 to 100,000 barrels. In an investigation in 1922, upon complaint brought against the Prairie Pipe Line Company, the Interstate Commerce Commission found that this company required a minimum tender of 100,000 barrels. Under the rule of the company, however, it was not necessary to actually deliver that amount from one tank or place at one time. The shipper having 100,000 barrels above ground might, after tender, hold it in storage, and the company would accept the current runs from his wells or his current purchases until the tender was filled. If the shipper desired to continue shipping he could make further tenders from time to time as the preceding tender neared completion, the company continuing to take his oil in small lots as produced or purchased. The Commission found, however, that this requirement necessitated an investment of about $450,000 in tanks and oil before shipment could commence, and that if a shipper desired to have current production or purchases accepted for transportation, approximately that amount of capital would have to be tied up continually in reserve storage and oil, thus precluding any but the larger operators from utilizing the pipe line facilities.[3]

[1] *Prairie Oil & Gas Co. v. U. S.*, 204 Fed. 798.
[2] *Pipe Line Cases*, 234 U. S. 548.
[3] *Brundred Bros. v. P. P. L. Co.*, 68 I.C.C. 458, 462, 463.

Arguments advanced before the Interstate Commerce Commission in justification of the requirement of large minimum tenders ran as follows: (1) it is necessary to have tenders made in large quantities to insure the pipe line company against loss in the extension of its gathering lines to new production; (2) it is impracticable from an operating standpoint to receive tenders of less than 100,000 barrels because of the added costs of closer surveillance to avoid running more oil from well storage into the pipe lines than is called for by the tender; and (3) with low minimum tenders there is likely to be a greater amount of contamination of higher grade by lower grade oils, since the oil is not only the commodity transported but a propelling agent, one lot being pumped in to force another lot through the pipes, it not being practicable to shut off the line while an entire consignment of one grade of oil is pumped through.

The Interstate Commerce Commission was not much impressed by the logic of the last two of these arguments, believing that though a reduction in the minimum-tender requirement would create new operation problems these could be solved without undue trouble and expense to the pipe line companies, although it was convinced that a reasonable minimum-tender requirement was justifiable in order to safeguard pipe line investment. However, the Commission found that 100,000 barrels was too high. It tended to exclude small shippers and thus to deprive pipe lines of their common-carrier status. With practically no precedent as to a reasonable minimum tender the Commission ordered that the Prairie Pipe Line Company reduce its requirement for shipments to the points in question from 100,000 to 10,000 barrels. In justification of its order the Commission said:

> The transportation of oil by pipe line is essentially a bulk business, and that fact must not be lost sight of in determining the issue now under consideration. The pipe lines cannot be successfully operated on a driblet basis, and there is a reasonable minimum below which they should not be required to accept oil for transportation. But the minimum must be reasonable, and it is clear that that fixed by defendants does not square with the law in this respect. Rather it reserves the pipe lines to a few large shippers and essentially deprives the lines of the common-carrier status with which they are impressed by the Interstate Commerce Act.[1]

[1] *Op. cit.*, p. 466.

The complaint against the Prairie Pipe Line Company also charged that its rates were excessive, but the Commission held that they were not. The proceeding involved only the shipments of this company and only to certain points; consequently, the order of the Commission had a very limited application. It was followed later, however, by voluntary reductions in the minimum-tender requirements to other points by the Prairie Pipe Line Company, due to the competition of California crude shipped to the Atlantic seaboard by tanker. The result was a large increase in pipe line shipments to eastern independent refiners, as shown in Table 34.

TABLE 34.—PIPE LINE DELIVERIES OF MID-CONTINENT CRUDE PETROLEUM TO EASTERN STANDARD AND INDEPENDENT REFINERIES, JANUARY, 1921–JUNE, 1926

Year	Standard refineries (barrels)	Independent refineries (barrels)	Total (barrels)
1921	47,790,374	43,500*	47,833,874
1922	50,990,917	146,812*	51,137,729
1923	45,581,832	504,107	46,085,939
1924	36,653,962	4,177,606	40,832,568
1925	42,648,325	6,406,582	49,054,907
1926 (6 months)	19,872,956	3,908,318	23,781,274

* 43,500 barrels in 1921 and 122,000 barrels in 1922 were to the Tide Water Pipe Company, presumably for the Tide Water Oil Company in which the Standard Oil Company (N. J.) held a substantial stock interest.

Source: Federal Trade Commission, "Report on the Petroleum Industry," 1928, Senate Doc. 61, 70th Cong., 1st Sess., p. 41.

These developments were of considerable importance to small independent producers and refiners, but the feeling that those who owned the pipe lines, because of their connections with producers and refiners, were in position to control the petroleum industry to the exclusion of small independents persisted. The Federal Trade Commission, directed by the United States Senate to investigate monopoly conditions in the petroleum industry, found that a more general use of pipe lines for the shipment of crude petroleum from the Mid-Continent fields would enable eastern independent refiners to become a more important factor in the petroleum industry, and that the pipe line companies themselves might profit by a larger volume of business. It recommended that

. . . unless the Standard lines running eastward from the Mid-Continent oil fields voluntarily accept common-carrier shipments on terms that enable both Standard and independent companies to use them freely, there should be absolute dissociation of pipe line ownership from interests engaged in producing and refining crude petroleum in order to establish free and fair competition in this branch of the petroleum industry.[1]

More has been heard recently of the proposal to divorce the pipe line companies from connections in the production or refining divisions of the petroleum industry. A bill was introduced into the Seventy-first Congress proposing to accomplish this purpose by applying the so-called "commodities clause" of the Interstate Commerce Act to pipe line companies. The "commodities clause" is paragraph 8, section 1, of the act, which provides that railroads shall not transport commodities in which they have a monetary interest, except such as are necessary in the conduct of their business as common carriers. However, nothing came of this measure. One of the principal groups supporting it consisted of small refiners who were fearful of the effect upon themselves of pipe line transportation of gasoline. Since this would be cheaper than rail transportation, they felt that in order to meet the prices of their competitors they would be compelled to ship by pipe line. Hence they were desirous that pipe line companies be divorced from the other branches of the petroleum industry so that their primary interests would be in harmony with their common-carrier obligations.

In recent hearings on a code for the petroleum industry the so-called independents, which confine themselves to one or two of the four principal operations in the industry, whereas the major companies generally carry on all four, again insisted upon a complete separation of pipe lines from other branches of the industry. They contended that profits from the pipe lines have been used by the major companies to offset losses in marketing and production, thus giving them a great advantage over the smaller companies in marketing. They set up a method for ascertaining cost, the purpose of which was to

. . . require every division of an integrated company to operate at a genuine profit, and to preclude the marketing of petroleum products

[1] Federal Trade Commission, "Report on the Petroleum Industry," Senate Doc. 61, 70th Cong., 1st Sess., p. 42.

below cost through the bookkeeping method of selling the refined products to the marketing division at less than the refining-division cost thereof—that is, taking of losses in the producing and/or refining divisions in order to warrant an ultimate marketing-division price which, though actually a loss to the marketer, shows an apparent bookkeeping profit in the marketing division.[1]

In summary, it may be said that pipe line companies are legally subject to regulation, those engaged in intrastate transportation in some instances by the states in which they operate, and those engaged in interstate commerce by the Interstate Commerce Commission. In practice, however, there has been no regulation of pipe line rates in interstate commerce, and but little regulation of the practices of the interstate pipe line companies. This has been due to the fact that while pipe lines are common carriers they transport oil mostly for themselves or the interests with which they are associated. Unlike the railroads, the pipe line companies, or associated interests, mostly own the commodity which they transport. Small producers do not ship the oil as a rule; they sell it to purchasing companies which are generally related to pipe line companies. Independent refiners having no pipe line affiliations purchase crude oil from the pipe line companies, or infrequently from producers and have it shipped by the pipe line companies. It is this latter group of companies which lie outside the general organization of the industry. Rate regulation without adequate cost studies cannot be effectual, yet so far no complete studies of pipe line transportation costs have been made. Nor can regulation be effectual without commission control of the top companies because of the high degree of integration of the industry. The first of these requirements could be met by the Interstate Commerce Commission if it were given the necessary personnel, but the second would require an extension of its powers.

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CHAPTER XI

TELEPHONE COMMUNICATION

Growth and Development.—The growth of the telephone industry, both in size and in efficiency, represents one of the most outstanding developments in the industrial history of the United States. From the mere scientific toy which Bell exhibited at the Centennial Exhibition, in Philadelphia, in 1876, has grown an industry involving an investment of billions of dollars, employing hundreds of thousands of persons, and furnishing communication service to every community and most of the farms of the United States. The telephone is primarily a medium for local communication, a fact which has had much to do with the development and organization of the industry. Today, there are about 45,000 telephone systems and lines in the United States, most of them being small units.

The size of the telephone plant and the volume of communications have increased tremendously. Miles of telephone wire reported by all telephone systems and lines to the Bureau of the Census increased from 4,900,451 in 1902, to 87,677,586 in 1932; while the number of telephones increased from 2,371,044 to 17,424,406 during the same period. The number of messages is not available for all companies, but for the Bell System, exchange conversations increased from a daily average of 9,322,951 in 1902, to 62,365,000 in 1930, and toll conversations, from a daily average of 239,689 in 1902, to 2,933,000 in 1930, the latter year being the year in which the peak for total conversations was reached. The principal statistics for all public telephone systems and lines in the United States for the years 1922, 1927, and 1932 are summarized in Table 35.

A very large proportion of the telephone business of the United States is conducted by a single organization, the American Telephone and Telegraph Company and its associated companies. The preponderance of the Bell System is shown both in the physical plant and in the volume of traffic handled. The

TABLE 35.—SUMMARY OF PRINCIPAL STATISTICS, ALL PUBLIC TELEPHONE SYSTEMS AND LINES, 1932, 1927, AND 1922

Item	1932	1927	1922	Percentage of increase (– denotes decrease)		
				1927–1932	1922–1927	1922–1932
Number of systems and lines	44,828	60,148	57,253	–25.5	5.1	–21.7
Total miles of wire	87,677,586	63,836,182	37,265,958	37.3	71.3	135.3
Number of telephones	17,424,406	18,522,767	14,347,395	– 5.9	29.1	21.4
Residence	11,089,946	12,128,617	*	– 8.6		
Business	6,334,460	6,394,150	*	– 0.9		
Number of calls originating with systems reporting	30,048,165,513	31,614,172,621	24,647,560,860	– 5.0	28.3	21.9
Number of central offices	19,228	20,227	19,260	– 4.9	5.0	– 0.2
Revenues, operating	$1,061,530,140	$1,023,573,567	$ 665,568,279	3.7	53.8	59.5
Exchange	$ 752,338,774	$ 701,381,400	$ 467,231,512	7.3	50.1	61.0
Toll	$ 281,047,593	$ 294,625,256	$ 180,069,891	– 4.6	63.6	56.1
Number of employees	334,085	375,272	312,015	–11.0	20.3	7.1
Male	128,677	131,802	104,433	– 2.4	26.2	23.2
Female	205,408	243,470	207,582	–15.6	17.3	– 1.0
Salaries and wages	$ 458,116,677	$ 486,597,070	$ 352,925,570	– 5.9	37.9	29.8
Investment in plant and equipment	$4,791,902,525	$3,548,874,716	$2,205,183,150	35.0	60.9	117.3

* Not called for on schedule.

Source: U. S. Bureau of the Census, "Telephones and Telegraphs," 1932, p. 9.

proportion of total telephones in the United States owned by the Bell System, which was 55.6 per cent in 1902, declined to 51.2 per cent in 1907, but thereafter increased to 58.3 per cent in 1912, to 62.5 per cent in 1917, to 66.3 per cent in 1922, to 74.1 per cent in 1927, and to 79.2 per cent in 1932. In 1932, of the 30,048,165,513 calls originating on the lines and systems reporting to the Bureau of the Census, 25,061,085,648 were originated on the lines of the Bell System; and of the $1,061,530,140 operating revenues received by those systems, $956,354,529 were received by the Bell System.[1] A comparison of the Bell System with all other systems and lines for the years 1902 to 1932 is presented in Table 36. The decline in the number of systems and lines included in the Bell System from 1917 to 1922 was due to the fact that prior to 1922 there were included in those figures data for a number of relatively small systems and lines controlled by the constituent Bell companies. Thus, of the 145 companies included in 1917, 37 were constituent companies and 108 controlled companies. As the result of reorganization and changes in ownership the number of constituent companies was reduced to 25 in 1927, while the number of controlled companies was reduced to 65. The controlled companies far outnumber the constituent companies, but they are relatively small. In 1927, investment in plant and equipment reported by controlled companies amounted to only 1.7 per cent of the investment reported by the Bell System; and the corresponding percentages for number of telephones and total operating revenues were only 2.4 and 1.5 respectively.[2]

While the great bulk of the telephone service of the United States is carried on by the Bell System, there are more than 6,000 independent companies which furnish service mostly in the smaller towns. In normal times these companies operate about 4½ million telephones. They own hundreds of thousands of miles of toll lines and they connect with the toll lines of the Bell System. Outside of cities of more than 50,000 population they serve approximately as many subscribers as the Bell companies. The independent companies operate the only telephone exchanges in more than 14,000 communities. On Dec. 31, 1934, there were in the Bell System 13,458,000 tele-

[1] U. S. Bureau of the Census: "Telephones and Telegraphs," 1932, p. 2.
[2] U. S. Bureau of the Census: "Telephones," 1927, p. 32.

phones, which together with the telephones of 6,700 connecting companies, and 25,300 connecting rural lines, made a total of 16,800,000 telephones that were interconnected.[1]

TABLE 36.—COMPARISON OF THE BELL SYSTEM AND ALL OTHER SYSTEMS AND LINES, 1902–1932

Systems and lines	Census year	Number of systems and lines	Miles of wire	Number of telephones
All systems and lines	1932	44,828	87,677,586	17,424,406
	1927	60,148	63,836,182	18,522,767
	1922	57,253	37,265,958	14,347,395
	1917	53,234	28,827,188	11,716,520
	1912	32,233	20,248,326	8,729,592
	1907	22,971	12,999,364	6,118,578
	1902	9,136	4,900,451	2,371,044
Bell System	1932	25†	80,585,879	13,793,229
	1927	25†	56,819,036	13,726,056
	1922	26†	30,613,687	9,514,813
	1917	145	23,133,718	7,326,858
	1912	176	15,133,186	5,087,027
	1907	175	8,947,266	3,132,063
	1902	44	3,387,924	1,317,178
All other systems and lines	1932	44,803	7,091,707	3,631,177
	1927	60,123	7,017,146	4,796,711
	1922	57,227	6,652,271	4,832,582
	1917	53,089	5,693,470	4,389,662
	1912	32,057	5,115,140	3,642,565
	1907	22,796	4,052,098	2,986,515
	1902	9,092	1,512,527	1,053,866

† Not including Bell-controlled companies; previous to 1922 these were included with the Bell System, but for 1922, 1927, and 1932 they are classified under "all other systems and lines."

Source: U. S. Bureau of the Census, "Telephones and Telegraphs," 1932, p. 24.

The bulk of the telephone service is exchange service, that is, service performed within the same exchange, the boundaries of which usually are contiguous with municipal boundaries. Many devices and service improvements have been developed which adapt the exchange service to those who have special com-

[1] Annual Report of the American Telephone and Telegraph Company, 1934, p. 18.

munication needs. In the residence service, might be mentioned extension telephones and elaborate wiring plans for large residences, portable telephones equipped with cord and plug, receivers with amplifying units for the hard of hearing, and many others. In the business service, the principal developments have been private branch exchanges, code-calling equipment, order-turret service, mechanical interconnecting systems which do not require a switchboard or an attendant, and private lines not connected to the general telephone system. Of these the most important is the private-branch-exchange service. A private branch exchange provides interconnection between the telephones connected to it without going through the central office, as well as connection with the public telephone system. Such exchanges in size range from the small cordless ones with a few extensions to large ones with thousands of extensions, employing as many operators as are employed by many small telephone systems. Private-branch-exchange telephones constitute about one-fifth of the total number of telephones in the Bell System.

Long-distance Telephone Communication.—Although the telephone is principally a means of local communication, an outstanding development in the United States is its use for long-distance communication. A very large proportion of the total long-distance messages are handled by the Long Lines Department of the American Telephone and Telegraph Company. These lines provide interconnection between the territories of the associated companies of the Bell System, and with telephones in other countries. The first intercity telephone line was constructed between Boston and Lowell, Massachusetts, in 1879. The next year a line was completed from Boston to Providence, which was followed, in 1884, by a line between Boston and New York, and soon thereafter by a line between New York and Philadelphia. Many technical developments, like the loading coil and the repeater, came to make telephonic communication over long distances feasible, and a line which was completed from New York to Chicago in 1892 was extended to Denver in 1911. In 1915, the first transcontinental circuit to San Francisco was completed. This was followed, in 1923, by a second transcontinental circuit from New York to Los Angeles; and by a third, in 1926, from New York to Seattle. In 1921, three telephone cables were laid from Key West to Havana,

which were followed by a fourth in 1931; and commercial telephone service between the United States and several Mexican points was opened in 1927. These developments, together with connections with the Canadian telephone system, spread a network of interconnected lines over a large part of the North American continent.

The toll system has grown extensively, and it has been improved in reliability and efficiency. The carrying capacity of toll lines has been increased greatly by the application of "phantom" and "carrier-current" principles, the former producing three practical talking circuits from two pairs of wires, and the latter several telephone circuits in addition to the voice-frequency circuit on a single pair of wires. Reliability has been increased by the provision of alternate routes, and the use of aerial cable to replace open wires. The long-distance circuits are used for network radio broadcasting, and for telegraph, as well as for telephone, communication. For example, there are 93 direct circuits which connect New York with Chicago, divided as follows: 63 used largely for long-distance calls between these cities; 10 which have been specially designed and constructed for transmitting program material for broadcast purposes; 15 which are used for voice-frequency telegraph systems and provide 180 telegraph circuits; and 5 set up for emergency use. In addition, there are assigned to these same routes other circuits connecting intermediate cities or cities beyond the terminals of this section.[1]

Improvements in methods of operation have increased greatly the efficiency of toll telephone service. Formerly, the short-haul toll calls, which constitute the bulk of the toll service, were handled in the same manner as long-distance calls, but today about 70 per cent of the toll business of the Bell System is handled at local switchboards along with exchange calls. Service on the long hauls, mostly over 60 miles, is given through separate toll boards. Other improvements have reduced the amount of unsatisfactory transmission, the number of cutoffs and other interruptions, and have increased the speed of making connections. As a result, during the past decade the average time necessary to complete a long-distance connection has been

[1] PILLIOD, J. J., Systems of Long Distance Telephone Lines, *Bell Telephone Quarterly*, vol. XIII, January, 1934, p. 29.

reduced from more than 9 minutes to less than 1½ minutes. At present about 90 per cent of toll-board calls are handled while the customer remains at the telephone.[1] The growth in the number of long-distance messages handled over the lines of the American Telephone and Telegraph Company is shown in Fig. 10. There has been a steady increase in the average length of haul of long-distance calls over these lines, from an average of 142.9 miles in 1922, to an average of 176.2 miles in 1930.[2]

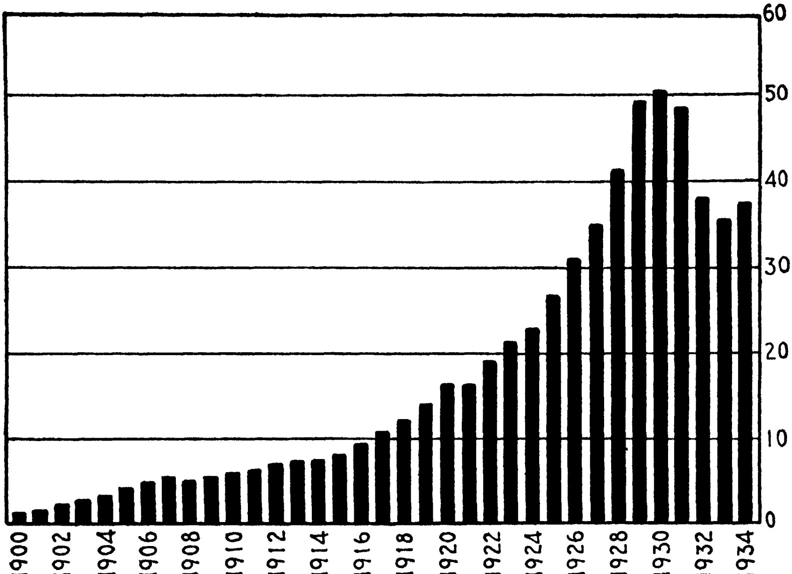

FIG. 10.—Long-distance telephone messages in millions. (*American Telephone and Telegraph Company.*)

Radiotelephony.—Until 1927, telephone communication with foreign nations was limited to countries to which wires or cables could be run, but in January of that year commercial application of radiotelephony was made, with a circuit between New York and London. This original circuit was soon supplemented by others and the telephone service has been extended to Europe, Africa, Australia, and the Orient; to South America, by the joint use of the facilities of the American Telephone and Tele-

[1] FRENCH, M. B., Improvements in Telephone Service, *Bell Telephone Quarterly*, vol. XII, January, 1933, pp. 11–20.

[2] WILLEY, M. M., and S. A. RICE, "Communication Agencies and Social Life," p. 141, McGraw-Hill Book Company, Inc., New York, 1933.

graph Company and the International Telephone and Telegraph Corporation; and to Hawaii, through the facilities of the Transpacific Communications Company, a subsidiary of the American Telephone and Telegraph Company, and the Radio Corporation of America. By the end of 1934, all countries with more than 100,000 telephones, except New Zealand, China, and Russia, in all, 60 countries, could be reached by telephone from the United States, and about 92 per cent of all telephones in the world were interconnected.

The volume of overseas telephone conversations increased annually until 1932, the first four years of operation showing a sixfold increase. The number of messages declined for the first time in 1932, increased again in 1933, but fell off in 1934. The increase in traffic has been due to the lowering of rates, improvements in the service, and a steadily increasing number of points reached. Rates to Great Britain, for example, have been reduced from the original rate of $75 for the first three minutes and $25 for each additional minute, to $21 for the initial period and $7 for each additional minute. Other rates have been reduced correspondingly. The principal users of the service are bankers and brokers, the press, government officials, merchants, and professional people. Social calls make up a large part of the transatlantic telephone traffic, an early analysis showing 48 per cent of the total to be social calls.[1] The overseas telephone traffic for 1934 was divided as follows: Ship-to-shore, 2,842; transpacific, 1,452; South and Central America, Bermuda, and the Bahamas, 2,972; and transatlantic, 12,067 messages.[2] The greatest demand for the transatlantic telephone service, like that for cable and radio service, comes during those periods of the day in which the business hours in America and Europe overlap.

In addition to the overseas telephone service, the American Telephone and Telegraph Company furnishes ship-to-shore telephone service with 19 transatlantic liners. Also, radio stations have been established for ship-to-shore telephone service with tugboats and other harbor craft at Boston, New York,

[1] MILLER, T. G., "Transoceanic Telephone Service," American Telephone and Telegraph Company, p. 10.

[2] Annual Report of the American Telephone and Telegraph Company, 1934, p. 26.

Seattle, San Francisco, and Los Angeles. A further extension of the harbor telephone service has been made to ocean liners while in dock.

World Telephone Statistics.—Telephone development is more extensive in the United States than in any other country. According to the chief statistician's division of the American Telephone and Telegraph Company, the total number of telephones in the world as of Jan. 1, 1934, was 32,495,855. Of these, there were in the United States 16,710,858 telephones, or about 51.4 per cent of the world's total. Europe had 11,306,955 telephones, or about 34.8 per cent of the total. The remaining 4,478,042 telephones, or about 13.8 per cent, were distributed among the countries of Asia, Africa, Oceania, and the western hemisphere outside the United States. The United States had also the greatest intensive telephone development, with 13.29 telephones per 100 population. Canada was second with 11.15 stations per 100 population; then followed, in order, New Zealand with 10.01, Denmark with 9.99, and Sweden with 9.51 telephones per 100 population, respectively. Of the major European countries, Great Britain had a development of 4.78, Germany 4.48, and France 3.19 telephones per 100 population. The highest development in any South American country was in Argentina, where there were 2.64 telephones per 100 population. In Asia, most of the telephones were concentrated in Japan, with a development of 1.5 telephones per 100 inhabitants.

A significant feature of telephone development in the United States is the extent to which less densely populated communities are supplied with telephones. On Jan. 1, 1934, there were in the United States, in communities of less than 50,000 population, 9.76 telephones per 100 inhabitants, this being higher than the total development of all other countries, with the exception of Canada, New Zealand, and Denmark. Corresponding figures for Great Britain, Germany, and France were 3.18, 2.69, and 1.84 telephones per 100 inhabitants, respectively, in communities of less than 50,000 population. Telephone development in these countries was concentrated mainly in the larger cities. London had more than 37 per cent of all the telephones in Great Britain, Paris more than 30 per cent of all those in France, and Berlin more than 15 per cent of all the telephones in Germany. Telephone development in the large cities also was generally

higher in the United States. Of the 12 cities having the highest development, 9 were American cities. Washington, D. C., had the highest development, with 35.31 telephones per 100 inhabitants. Then followed, in order, San Francisco with 35.00, and Stockholm with 31.95. Except for Stockholm, Sweden, and the two Canadian cities, Vancouver (27.51) and Toronto (24.44), no large foreign city had a better telephone development than the first 35 ranking cities in the United States.[1]

Economic Characteristics.—One of the principal characteristics of public utility services is their indispensable nature. In this respect the telephone is outstanding. Its uses are too well known to need repetition here, however. How important the telephone is to our normal business and social activities is appreciated only when the system is out of order.

The telephone service, certainly the local service, is a natural monopoly. This is due to the fact that in order that a subscriber may receive a complete service it must be possible to connect him with every other subscriber. Obviously, this can best be done by one company. With two companies serving the same area, subscribers, if they should desire a complete service, would have to install the telephones of both companies, such procedure being uneconomical. Theoretically, physical connection between competing companies would enable subscribers of the different companies to call each other, but such connection is hard to bring about under a system of private ownership, even where state public service commissions have been given authority to compel physical connection. Physical connection between telephone companies, where established, is practically always for the purpose of giving one the use of the other's long-distance lines.

Large-scale operation in the telephone industry, in the exchange service, produces results differing greatly from those produced by large-scale operation in most other utilities. The cost of telephone service per station increases with the number of subscribers; thus rates for a large exchange must be higher than those for a small exchange. This is true even though the general office expenses and the commercial expenses of a telephone company tend to diminish per station with the growth in number

[1] World Telephone Statistics, *Bell Telephone Quarterly*, vol. XIV, July, 1934, pp. 218–228.

of subscribers, due to the fact that the general officers and their staffs and the clerical forces do not increase proportionately with the increase in stations, and to the further fact that there is usually the introduction of more efficient office methods. The long-distance service is furnished at decreasing costs.

Many factors are responsible for the increasing cost per station of furnishing exchange service. In the first place, investment and operating costs per station of central offices and substations increase. Switchboards not only increase in size but in complexity of operation. Change from the simple magneto type to the common battery type of switchboard adds to investment and operating costs, and switchboard facilities must increase with each new subscriber. In a small exchange this is not especially significant, since only one line is required for each subscriber and an operator sitting at the board in a single position can reach every subscriber. But in a large exchange, employing three or more operators, the lines for each subscriber must be within the reach of each operator. This requires more than one switchboard jack and associated equipment for each subscriber's line. Moreover, as the central station increases in size, more space becomes necessary to house the complex equipment. Expense in this respect is often affected by rising real estate values and taxes.

In the second place, operating costs increase because an increased force of operators is necessary. This is due not only to the fact that the number of calls increases—at least up to a certain point, there is a tendency for the calling rate to rise with growth in the size of the exchange—but also because the average call consumes more of the operator's time. A larger proportion of calls are trunked from one central office to another, and more time is consumed in such trunked calls than where the subscribers are on the same central office. Also central-office maintenance costs tend to rise with increased complexity of the equipment, due in part to the fact that a more skilled maintenance man is required and higher wages must be paid. Further, service demands in large exchanges are more exacting and require speedier operation and maintenance service than in smaller exchanges. Higher service standards require more nonproductive labor for supervisory purposes, and a more costly maintenance personnel.

In the third place, total costs of the distribution system per station increase with the growth of the exchange. Poles must be larger and longer; more aerial cable must be used; more underground cables and conduits must be installed; pavements must be torn up and replaced in construction and repair work; labor usually becomes more expensive due to greater complexity of the distribution system and municipal regulations become more exacting. Maintenance costs per station also tend to increase with increased size of the exchange. The plant becomes more intricate, necessitating the employment of more skilled labor to maintain it; lines are more likely to be interrupted, since the average length of lines becomes greater; more time is required to maintain longer lines; and maintenance standards generally are higher. There are, however, certain offsetting factors to the tendency of distribution costs per station to increase with increased size of the exchange. The density of the territory served, as well as the extent, increases with the growth of the exchange, and this enables a more efficient utilization of pole lines, conduits, and cables.[1]

In the fourth place, certain hazards tend to increase with the size of the exchange. Fires in city districts become more destructive; induction troubles due to the proximity of other electrical conductors increase, as do conduction accidents due to short circuiting with high-voltage conductors, and the electrolysis of underground cables and other structures.[2]

There is some difference of opinion as to whether or not exchange service is furnished at increasing costs with increase of size of exchanges, due to the use of different units for measuring the service rendered. The unit of measurement commonly used is the number of stations, although others may be used, such as the number of calls, the number of call-miles, the number of call-mile-minutes, etc., which might indicate a different tendency. It is a significant fact, however, that it costs more to furnish the same grade of telephone service to an inhabitant of a large community than to an inhabitant of a small one, and

[1] Sickler, B. G., in H. B. Dorau, "Materials for the Study of Public Utility Economics," p. 361, The Macmillan Company, New York, 1930.

[2] Montana Public Service Commission in *Pub. Service Commission v. Mountain States Telephone and Telegraph Co.*, P.U.R. 1924C, 453, 645–647.

this stands in contrast with the general tendency of unit costs to decrease with increase in the scale of operations.

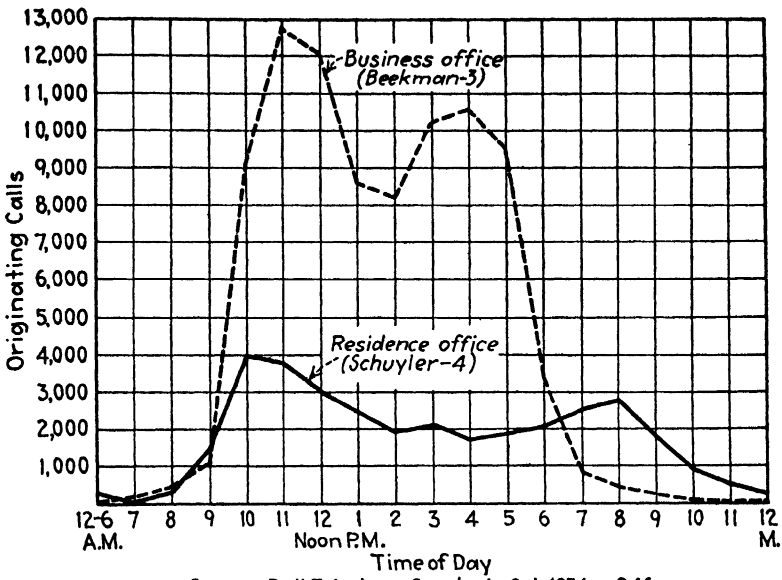

FIG. 11.—Distribution of exchange calls by hours.

Telephone costs are affected by the hourly distribution of traffic. Variations in the number of exchange calls by hours

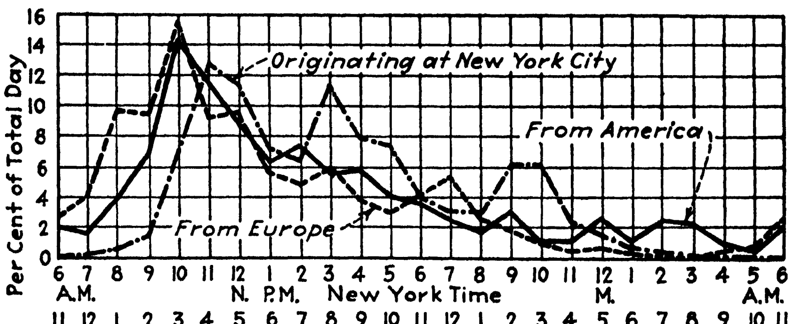

FIG. 12.—Distribution of long-distance and transatlantic calls by hours. — · — · — · toll board calls originating at New York; ———— transatlantic, from America; - - - - - transatlantic, from Europe. (*American Telephone and Telegraph Company.*)

in typical business and residence offices in New York City are shown in Fig. 11. The hourly distribution is not the same for

business and residential offices, and there is considerable variation between different sections of a city. The uneven hourly distribution requires that facilities be provided to handle peak traffic which are partly unused at other times, and in manual exchanges, creates many difficult operating problems. Dial-system equipment is, and must be, engineered with reference to the peak load. The volume of long-distance and transatlantic telephone traffic also varies greatly during different hours of the day, as shown in Fig. 12.

Development of off-peak use of the telephone service to improve load factor is limited by the very nature of the service. The telephone company merely furnishes a connection; the parties themselves carry on the communication. This requires the presence of both parties on the line, and the general tendency is to use the telephone only when it is convenient for both parties. A further fact is that a very large part of all telephone calls arise from the normal conduct of business operations, and these are necessarily confined to the business day. Attempts to improve load factor in the long-distance service have been made by offering lower rates for off-peak use, and with considerable success. Development of off-peak use of the overseas telephone service, as well as the service as a whole, is handicapped by time differentials.

TELEPHONE RATE MAKING

Exchange and Toll Rates.—The telephone service is divided into two major classifications: exchange service and toll service. In the early days of telephone development no such distinction was made, but it is done universally at the present time. The reason for this twofold classification is the wide variation in the demands for the two classes of service among telephone subscribers. All subscribers make use of the exchange service, which constitutes the bulk of the telephone business, but not all use the toll service, and there are wide variations in demand among toll users. It is estimated that the great majority of toll calls come from less than half of the telephone subscribers. Therefore, to make all subscribers bear a part of the costs of furnishing toll service is to require certain ones to pay for a service they do not receive. Obviously, there are only two methods of dealing fairly with all telephone subscribers. One is

to set up a separate toll system supported by those who use it, an uneconomical and unnecessary procedure; and the other, to separate the toll and exchange services in the matter of charges. The latter method is the only practical one, but it is a difficult matter to determine proper levels of exchange and toll rates, since much of the property and many of the employees are utilized jointly in the performance of both services. Cost allocations and the relative demands for the two services must be the guiding factors, for if toll rates are too low exchange subscribers are being burdened unduly, and if they are too high, the development of the toll service is hampered.

Exchange Rates. 1. *Business and Residence Rates.*—Exchange rates are subclassified into business and residence rates. The former are universally higher than the latter. This practice is not based on the theory that it costs more to furnish the business service than the residence, for in many instances it may cost less, the investment in outside plant being less. It is based upon the strength of the demand for the service, business users as a whole having more urgent needs for telephone service than residence users. The classification becomes difficult to make in the case of professional people who have their business offices in their homes, draymen, contractors, photographers, seamstresses, and others who maintain no separate business offices, public schools, churches and societies, fraternities and boarding houses. The rules for classification are laid down by the companies and must be approved by the public service commissions, but interpretation of the rules often involves conflicts of opinion.

2. *Individual-line and Party-line Rates.*—Both the business and the residence rates are subclassified into individual-line and party-line rates. Party-line rates are lower than individual-line rates. In the first place, it costs little more to serve two or more parties attached to a line than to serve an individual-line subscriber. In the second place, party-line rates are lower so as to stimulate the development of the service, this being of importance to all subscribers, for in the telephone service the addition of new subscribers increases the value of the service to old subscribers. In some large cities only individual or two-party service is provided, although in many, four-party residence service is common. In the rural service, eight-party or ten-party service is quite common, with sometimes as many as

fifteen parties on a single line. The tendency at present, however, is away from such heavy loading of lines because of the poor quality of service rendered.

3. *Flat Rates and Measured Rates.*—Exchange rates, except in the larger cities, are flat rates, in contrast with water, gas, and electric rates in the same communities, which are generally measured rates. Measured rates, as a rule, consist of a minimum monthly charge which entitles the subscriber to originate a limited number of calls, and an additional charge for each call in excess of the maximum allotted number. The minimum charge, and the number of calls permitted under it, are not the same for business and residence service, and they vary with the class of service, whether individual or party line. In many cities both measured and flat rates are employed in the residence service, the subscriber choosing between them. Flat rates in the telephone service have the following advantages:

a. They are easy to administer.

b. They tend to enhance the value of the service in the eyes of the subscriber, since he is given unlimited use of his telephone, and thus to aid telephone development.

c. They do not require the installation of expensive machinery or the additional labor necessary for measuring the service.

The disadvantages are:

a. They discriminate unfairly against the small users of the service in favor of the large users.

b. They tend to encourage wasteful or unnecessary use of the telephone service and thus to increase its cost to all subscribers, as well as to lower the quality of the service or to hamper its improvement.

Measured rates meet the objections offered to flat rates, but the fact that flat rates still remain the most common type of rates is not altogether to be deplored. In manual exchanges, among residence subscribers, differences in the amount of use of the telephone are not great enough to justify the expense of measuring the use. Among business users, however, amounts of use vary more widely, and business measured service is accordingly much more common than residence measured service. From the standpoint of the development of the service, flat rates are of considerable importance, for even though it were possible to allocate costs to the various subscribers in proportion

to the service rendered, rates would still have to be made with a view to the value of the service to the various classes of subscribers. The freedom of use which goes along with flat rates adds greatly to the value of the service to many subscribers.

Some have contended[1] that measured telephone rates should be two-part rates; one part consisting of a service charge, and the other a charge for each call originated. The principal arguments for the adoption of two-part telephone rates are that they would bring about a more equitable distribution of costs among the various subscribers, and would enable a greater development of the service to take place. There are in our larger cities many people—laundresses, day workers, seamstresses, jobbing carpenters, and odd-jobs people in general—who cannot pay for telephone service at present rates, and who would make little use of telephones once installed, but who for considerations of economy and efficiency should be accessible to telephone subscribers. It is contended that if the costs dependent upon the provision of equipment to handle peak load and those dependent upon the number of customers are segregated out and made the basis of a service charge, a charge per call sufficient to cover the costs dependent upon the quantity of service given could be made so low as to encourage use.

Objections to the use of two-part rates are: (1) it would be impossible to determine the demand costs for any particular consumer because of the difficulties likely to be encountered in segregating the costs of furnishing toll and exchange service, as well as the costs of furnishing different classes of exchange service; and (2) a demand charge equal to the demand costs, if ascertained, would of necessity be so high as to check development, or even to reduce the number of subscribers.[2] The principal difference between these contrasting viewpoints is with respect to the effect which the introduction of a demand charge would have upon those whose demands for telephone service are neither large nor pressing. This, however, could hardly be determined short of actual experiment.

[1] Lyndon, L., "Rate-Making for Public Utilities," Chap. XIII, McGraw-Hill Book Company, Inc., New York, 1923; also, Sickler, B. J., A Theory of Telephone Rates, *Journal of Land and Public Utility Economics*, vol. IV, 1928, pp. 180–184.

[2] Jones, Eliot, and T. C. Bigham, *op. cit.*, pp. 370–371.

4. *Private-branch-exchange Rates.*—Private-branch-exchange service (called P.B.X. service) may be charged for at flat rates or measured rates. In flat-rate districts, charges usually consist of rates for the trunk lines the same as for individual lines; rental for the switchboard, depending upon the size and the type of the board; and charges for each station connected to the board. In message-rate districts, besides similar charges for the switchboard and stations, the charge for the first trunk line usually includes all messages and is identical with the charge for an individual line in that district for the same number of messages. Additional trunks are charged for at a specified rate per trunk. No charge is made for calls between the interconnected telephones of the private branch exchange.

In connection with the furnishing of private-branch-exchange service, the issue of the resale of telephone service has been raised. If this were permitted, the owners of an office building or a hotel could install a private branch exchange and resell service to tenants or guests; so could department stores for their customers, railroads within the confines of their stations, and owners of all the buildings located in a city block might set up a joint exchange and require tenants to subscribe to their service. Public utility commissions generally have refused to compel telephone companies to furnish P.B.X. service under conditions which would permit the resale of telephone service. Objections to such practice have been stated by the New York Public Service Commission, as follows:

It would establish a third party between the telephone company and the users of its service.

The middleman would use only such equipment as he considered necessary.

All the company's dealings with the real users of its service would have to be through the medium of this third party, over which the company would have no control, since presumably the middleman would not be considered a utility.

Many difficulties would be thrown in the way of providing efficient service, not only from the standpoint of the telephone utility but also in the way of regulation, and service complaints would undoubtedly multiply with very little chance of reasonable or timely correction or adjustment.

If the practice were acknowledged and followed, there seems to be no limit to such utility service, because it could not be restricted to one building, nor to a group of buildings, nor even to an entire block.[1]

5. *Pay-station Service.*—Public pay stations, equipped with coin boxes, are installed for the convenience of the public. They make the telephone service, both local and long-distance, available to nonsubscribers, and to subscribers away from their own telephones. The rates are message rates.

Semipublic pay stations, also equipped with coin-collecting devices, are installed in public places for the use of both the general public and the subscriber. Such stations are so arranged that the subscriber may receive incoming calls and a telephone service be available to the public without either the subscriber or the telephone company having to pay for the misuse of the telephone by nonsubscribers. "Borrowed" calls, in the absence of semipublic pay stations, have been found in many instances to represent considerable proportions of the total telephone traffic.

6. *The Exchange or Base-rate Area.*—How large the exchange should be and what considerations should determine its boundaries are matters of importance both to subscribers and to telephone companies. As we have seen, total telephone costs per station increase with increase in the size of the exchange, and rates accordingly must increase. Where flat rates prevail the tendency is not only to accentuate differences in the amount of use by various subscribers but to raise the cost of telephone service above its value to many subscribers and thus to hinder telephone development.

To remedy such situations zoning systems with toll charges between zones have been tried in the past in some of our larger cities, but always with unsatisfactory results. In the first place, no matter where the zone line is located situations are created to which subscribers react unfavorably. It seems ridiculous and unfair to them that they should be asked to pay a toll to talk to neighbors across the street or in a near-by block. Yet zone boundaries must be drawn somewhere. The effect is to hinder telephone development. In the second place, limiting the size of the exchange area does not necessarily lower

[1] *Gelsam Realty Co. v. New York Telephone Co.*, P.U.R. 1929A, 224, 226.

the cost of telephone service to the small user, since his needs may cover as wide an area as those of the large user. Zoning may give him a lower flat rate, but the difference may be more than made up in tolls. In the third place, inter-exchange tolls in a zoning system are very objectionable to certain classes of business users who install telephones not only to call other subscribers, but to be called by them. Business men, in certain cases where zoning systems had been instituted, found it necessary to install telephones for more than one zone in order to save their patrons tolls.

It is generally agreed that zoning of large cities for telephone rate making creates artificial barriers to social and commercial communication and is an undesirable practice, since the business and social interests of the residents of larger cities are not necessarily regional in character. In some cases, however, optional rates have been established which permit the subscriber to elect a limited-zone service at lesser cost with toll charges to outside districts. Where an exchange, or base-rate area covers the entire city, other exchanges are established for suburban areas.

The establishment of exchange boundaries presents difficult problems for telephone company managements. If the boundaries were in all cases to be determined by radial lines extending equal distances from the central office, it would then be important that the central office be located approximately in the center of population, or in the economic center of telephone subscribers—a purely artificial arrangement. Moreover, a strict application of the distance principle often would place subscribers belonging to the same business or social community in different exchanges. The boundaries of an exchange must bear some relation to the distribution of population, the natural centers of business for the subscribers affected, and community of interests. To satisfy the needs of certain subscribers residing in one exchange area whose principal business and social connections are in another, "foreign exchange service" is often provided at special rates, lower than corresponding toll charges would be.

In the case of rural patrons living outside exchange areas, telephone companies often establish rates based upon mileage computations from the limits of the exchange areas, sufficient to meet, at least in part, the added cost of rural service. The

determination of such rates, however, must take into consideration the trade territories of exchange areas, as well as the community of interests between city and rural patrons. Strict application of the distance principle is often inadvisable, especially where a real estate development is in the nature of a colony having community of interests. In such cases, often a "locality rate," which is an average for the distances involved, is charged all patrons in the community. The principal obstacle to the development of rural telephone service is the cost of constructing and maintaining the lines in relation to the revenues which may reasonably be expected. Various plans have been adopted for the financing of rural extensions, most of which provide for the sharing of the fixed costs between the rural subscriber and the company.

Toll Rates.—Toll rates universally are message rates. The facts that not all subscribers make use of the toll service, that the amount of use as between subscribers varies greatly, and the further fact that distances to be covered vary greatly as between calls, necessitate the placing of the cost of the service directly upon those who use it. Toll rates increase with distance, the cost of service increasing with distance, and vary with the length of the conversation. In these respects they differ from exchange rates.

Toll rates are classified as to conditions limiting the completion of the call as specified by the user, as follows:

1. *Station-to-station service:* Where the user desires communication only with a specified telephone station.

2. *Person-to-person service:* Where the user desires communication only with a specified person or persons at a specified station.

3. *Appointment service:* Where the user desires communication only with a specified person or persons and only at a specified time.

4. *Messenger service:* Where the user desires communication only with a specified person or persons but where such demand can be met only by utilizing the service of a messenger.

The reasons for the above classification are: (1) to better adapt the service to the demands for it, and (2) to effect a more equitable distribution of the costs of furnishing toll service. The nonrevenue-producing use of toll facilities involved in

furnishing person-to-person service is greater than for station-to-station service, and in the case of appointment and messenger services still greater, since the circuits must be established at least twice, once in arranging for the appointment or messenger, and once for actual communication.

Toll rates are also classified as to hour of use. The present classification of the American Telephone and Telegraph Company applies only to broad periods designated as day (4:30 A.M. to 7:00 P.M.), and night (7:00 P.M. to 4:30 A.M.). Lower rates apply during the night period than during the day. The reasons for this classification are the differences in cost of furnishing service during these periods, and the desire to stimulate traffic at off-peak hours to improve load factor.

Toll rates, unlike exchange rates, vary with the length of conversation. The reasons are: (1) payments for toll service should be in proportion to the different quantities of service furnished; and (2) restrictions upon the length of conversation tend to reduce the amount of unnecessary conversation, and thus to keep down the total costs of furnishing toll service. With no restriction upon the length of calls they would tend to increase in length and make necessary the provision of additional toll facilities for the same number of calls.

The Toll-rate Structure.—Toll rates consist of the following general classes: (1) station-to-station initial-period day rates and night rates; (2) person-to-person initial-period rates; (3) appointment and messenger initial-period rates; (4) report charges; and (5) overtime rates. The problems of toll-rate making involve the establishment of proper differentials between the different rates for each class, and a proper relationship between toll rates as a whole and exchange rates as a whole.

All toll rates are based upon station-to-station initial-period rates, these rates being the simplest and cheapest charged. This method of determining rates is for convenience only. The proper relationship between the various classes is determined by the effect of the various rates upon the cost of furnishing the toll service and its development. Thus, person-to-person, appointment, and messenger rates are higher than station-to-station rates because of the greater quantity of service rendered, but the amount of the differential has an important bearing upon the development of the toll service and its cost. A

report charge is not a charge for a class of service. It is a charge made for certain calls which cannot be completed owing to circumstances beyond the control of the telephone company. Report charges are made for uncompleted person-to-person, appointment, and messenger calls. Initial periods are usually 3 minutes, with an additional charge for each minute in excess of 3.

The task of setting up schedules of station-to-station toll rates for the Bell System is a large one, since that system and its connecting companies reach almost 90,000 points. To obviate the necessity of computing rates from each point to every other point, which would entail the computation of billions of rates, a system of block rates has been devised. Up to distances of about 40 miles, toll rates of the Bell System are based upon the direct air-line distance as measured on United States government maps. These rates increase as distance increases.

Station-to-station rates for distances greater than 40 miles are computed on a group or block basis. The block system includes Canada, the United States, and Mexico, and is laid out on maps obtained from the respective governments. The system is made up of blocks each 7 miles square, and sections (composed of 25 blocks) each 35 miles square. The sections are lettered consecutively from north to south in capital letters, beginning in Canada, *A*, *B*, *C*, etc., and continuing *AA*, *BB*, *CC*, etc.; and numbered consecutively from west to east, beginning in the Pacific Ocean so as to include all continental points, 1, 2, 3, etc. The blocks of each section are lettered consecutively with small letters, *a*, *b*, *c*, etc. Each city is assigned the block and section number of the block and section in which it is located.

Between 40 miles and approximately 350 miles, station-to station toll rates are based upon the computed air-line distance between the centers of the 7-mile blocks, all points in a block taking the same block rates. For distances greater than 350 miles the rates are based upon the air-line distance between the centers of the 35-mile sections, all points in a section taking the same section rates. Rates increase with distance.[1]

Division of Joint Toll Rates.—Long-distance telephone service is furnished by the associated operating companies of the Bell

[1] Seven Billion Toll Rates, *Bell Telephone Quarterly*, vol. 8, p. 107, April, 1929.

System, by the connecting companies, and by the Long Lines Department of the American Telephone and Telegraph Company. The lines of the latter connect all the larger cities, but the messages originate on the lines of the operating companies or connecting companies, thus necessitating the use of the lines of two or more companies. Divisions of the tolls are made according to contracts between the American Telephone and Telegraph Company and its associated companies, or by the members of the Bell System with connecting companies. Within the Bell System, the originating company gets a commission for operating, billing, collecting, etc., which is a percentage of the total toll collected from the customer. The amount left after the deduction of the commission is divided between the companies on the basis of miles of circuit used. Such calculations are not made for each individual message, however, since this would involve an unnecessary amount of accounting. Studies are made for a test period of the number of toll messages originating at a certain exchange, the destinations, the tolls collected, etc. From these studies, an average commission and an average mileage prorate are derived, which are brought together into a single percentage figure. This is applied to all long-distances messages originating at the given exchange which are sent over the lines of the American Telephone and Telegraph Company, usually with a maximum allowance per call. Such tests are made frequently. Usually the division applies only on outgoing calls, the local company receiving no recompense on incoming calls. Similar contracts govern division of toll rates as between the Bell companies and the connecting companies.

Private-wire Services.—In addition to the regular exchange and toll services, the Bell System furnishes full-period or short-period talking service, private-wire telegraph service, and exchange teletypewriter service. Full-period talking service is furnished over private wires and short-period talking service by means of circuits between designated points, with terminals, drops, and such other facilities as are required, for communication during a given part of the day. The rates are based upon mileage; they vary with distance and with the time of day contracted for, being highest from noon to 4 P.M. Overtime rates are charged, and special charges are made for "drops" and "terminal loops."

Private-wire telegraph service is furnished by the Bell System in competition with private-wire services of the telegraph companies. The charges are annual mileage charges, plus installation and rental charges for the use of equipment. Teletypewriters are used on many of these private circuits and the development and installation of central switching apparatus have made it possible to connect a teletypewriter subscriber with any other such subscriber for instantaneous two-way written communication. Rates are based upon time, the initial period being 5 minutes with charges for overtime. No charge is made for the teletypewriter, payment being made only for actual connections.

For some time the Bell System conducted a telephotograph service in cooperation with the telegraph companies, and at one time the system included eight important cities of the United States. By this system pictures and documents, as well as messages, could be sent to distant cities where they appeared in absolute facsimile. Rates were based upon the area of the facsimile. This service never proved very profitable, however, owing to the high cost and the limited demand for it. Recently, the Associated Press approved the establishment of a telephotograph service for its members which uses equipment and facilities of the Bell System.

The Bell System also provides facilities to radio broadcasting for connections between studios and transmitters, between studios and points where programs originate, and for network broadcasting. Revenue accruing to the American Telephone and Telegraph Company from this program-transmission service amounts to more than $3,500,000 a year. This revenue is derived from the line and station service charges for full-time, recurring, and special-occasion services, with something over two-thirds accruing from permanently established full-time services.

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CHAPTER XII

TELEGRAPH COMMUNICATION

Growth and Development.—The telegraph industry, the oldest of the telecommunication industries, had its beginning in the practical applications of the inventions of Samuel F. B. Morse. The first commercial line was established by the United States government between Washington and Baltimore, and the first public message was transmitted over this line in 1844. The superintendence of this line was placed under the Postmaster General and, because of the close relationship between the postal and the telegraph services, there was considerable sentiment in favor of the retention of government control over the telegraph service. However, the line established was not self-supporting, appropriations for its maintenance were made grudgingly by Congress and, in 1847, it was sold to private interests.

With the demonstration of the commercial value of the telegraph, there followed a period of "wildcat" development, during which promoters with rosy dreams organized companies in many sections of the United States. By 1851, there were some 50 telegraph companies in operation, most of them licensed by owners of the Morse patents, although a few used other devices. One of the latter was the House printing telegraph, which transmitted messages by printing in plain roman letters, instead of dots and dashes. Lines to utilize the House system were built between New York and Boston and between New York and Philadelphia, prior to 1850. In 1851, a group of men, among whom were Hiram Sibley, Ezra Cornell, and Samuel L. and Henry R. Selden, acquired the rights to the House system and incorporated the New York and Mississippi Valley Printing Telegraph Company. This company constructed a number of lines, acquired others by purchase, and in 1856, the name was changed to the Western Union Telegraph Company.

The Western Union grew rapidly, acquiring control over many of its competitors which lost out in the competition. In 1861,

it completed the first telegraph line to the Pacific Coast; and in 1866, it absorbed the two other large companies then operating in the United States, thus obtaining a domination of the telegraph industry which it has retained until this day.

The next important competitor of the Western Union came into existence as a result of the incorporation of the Commercial Cable Company by John W. Mackay and James Gordon Bennett, and the laying of two transatlantic cables by this company in the early 1880's. These men realized that in order to develop a successful cable system they would need adequate land-line connections to internal points in the United States. Two alternatives lay before them: one, to negotiate a contract for interchange with the Western Union, which was also in the cable business, and the other, to develop a domestic telegraph system of their own. They chose the latter course and brought into existence the Postal Telegraph system, which has remained the principal competitor of the Western Union.

These two companies completely dominate the domestic telegraph business of the United States. Seven other small companies operate, but in 1932, of the total operating revenues of all telegraph and cable companies in the United States, Western Union accounted for 75.26 per cent; the International Telephone and Telegraph Corporation (parent controlling corporation of the Postal Telegraph and Cable Corporation), for 24.63 per cent; and these seven small companies, for only 0.11 per cent. Four of these companies were developed or acquired for the purpose of serving certain industries, two are connected with class I steam railroad companies, and only one is a truly public telegraph company competing with the Western Union and Postal systems.

The most complete statistics of telegraph development are those of the United States Bureau of the Census, which since 1902, has made a quinquennial census of the telegraph industry. Prior to 1902, however, such a census was made only for the year 1880. In that year, 77 telegraph companies reported to the Census Bureau, but by 1902 the number had fallen to 25, showing the effect of consolidations brought about by the Western Union and the Postal Telegraph during that period. Since 1902, the number of telegraph companies has declined steadily, although slowly. The number of telegraph offices, which in 1880 amounted to 12,510, increased to 27,377 in 1902,

and continued to a peak of 30,781 in 1912, from which the number declined to 25,901 in 1932. The decline in the number of offices after 1912 was due principally to reductions in the number of railway telegraph offices operated for commercial business. Miles of pole line increased from 110,727 miles in 1880 to 237,990 in 1902, and to 256,215 in 1932; miles of single wire owned and leased, from 291,213 miles in 1880, to 1,318,350 in 1902, and 2,259,827 in 1932.

The amount of business done, measured by either the number of messages or the income from telegraph traffic, shows substantial increases for each succeeding census period except the last. The number of messages (including cable messages of the Western Union, which are not segregated) increased from 31,703,181 in 1880 to 215,595,494 in 1927, but declined to 147,941,039 in 1932; while income from telegraph traffic increased from $13,512,116 in 1880 to $159,682,419 in 1927, but declined to $97,729,160 in 1932. A development of interest has been the shift from the telegraph to the telephone for the transmission of train orders in railroad operation. Before 1908, trains were dispatched almost altogether by telegraph, but the telephone has superseded the telegraph in an ever-increasing proportion of this business. Reports of the Interstate Commerce Commission show that as of Jan. 1, 1935, of 237,126 miles of road operated, 151,103, or 63.7 per cent, were telephone miles of road, and 93,907 were telegraph miles of road. The discrepancy of 7,884 miles between the telegraph and telephone miles and the miles of road operated, the Commission said, was due to the fact that some roads reported the same miles of road as being operated by both telegraph and telephone.[1]

It is a notable fact, however, that progress in the telegraph and cable industries has been materially slower than in most other utilities. Nor have they withstood the rigors of the recent depression so well. During 1929, the telegraph and cable companies carried their greatest volume of business. For that year the gross operating revenues of the Western Union were $145,667,195; and the telegraph, cable, and radio operating revenues of the Postal Telegraph and Cable Corporation, $38,556,665. The following years were years of rapidly declining

[1] *Proceedings*, Association of American Railroads, Telephone and Telegraph Section, 1935, p. 281.

business activity with consequent serious effects upon telegraph and cable earnings. The gross operating revenues of Western Union fell off sharply to a low of $82,308,606 in 1933, a decline of about 43 per cent from the 1929 peak. Telegraph, cable, and radio operating revenues of the Postal Telegraph and Cable Corporation showed a similar decline to $26,396,141 in 1933, a decline of about 32 per cent from the 1929 peak. With some revival of business activity in the latter part of 1933 and in 1934, telegraph earnings improved materially, the gross operating revenues of Western Union for 1934 rising to $87,230,227; and the telegraph, cable, and radio operating revenues of the Postal rising to $27,262,543. These fluctuations in telegraph and cable earnings demonstrate clearly how directly dependent they are upon the volume of business transactions. Census figures for land telegraph systems, for the years 1922, 1927, and 1932 are shown in Table 37.

Technical Development.—Throughout telegraph history technological improvements have wrought significant changes in the operation of telegraph systems. These improvements have multiplied many times the capacity of telegraph lines, and have changed the bulk of telegraph operation from manual to machine. Telegraph lines are now adapted to simplex operation, in which only one station can send at a time; duplex operation, where the equipment is so arranged that two-way simultaneous operation is possible; and multiplex operation, where multiple operation simultaneously in both directions is possible. Thus, on the trunk circuits of the Western Union, 8 messages may be transmitted simultaneously over 1 wire, 4 in each direction. In addition, to further increase the message capacity of telegraph wires, "carrier" circuits have been developed which make use of impulses in the higher frequencies unutilized by ordinary telegraph circuits. A pair of metallic circuits (4 wires) can be made to accommodate 8 carrier circuits, each of which may be multiplexed, thus permitting 18 simultaneous messages per wire. Telephone wires may also be adapted similarly to telegraph use. Both the Western Union and the Postal, in addition to their own multiplex and "carrier" systems, lease circuits from the American Telephone and Telegraph Company.

Related to the development of multiplex operation has been the development of printing-telegraph systems. A printing-

TABLE 37.—SUMMARY, LAND TELEGRAPH SYSTEMS: 1932, 1927, AND 1922
(Percentage not shown when base is less than 100)

Item	1932	1927	1922	Percentage of increase (− denotes decrease)		
				1927–1932	1922–1927	1922–1932
Number of companies or systems	17	18	19			
Miles of pole line*	256,215	254,720	252,991	0.6	0.7	1.3
Miles of single wire owned and leased†	2,259,827	2,138,259	1,845,237	5.6	15.9	22.5
Telegraph offices or stations	25,901	27,530	27,214	− 5.9	1.2	− 4.8
Messages sent	147,941,039	215,595,494	181,518,774	−31.4	18.8	−18.5
Employees	60,933	74,903	62,299	−18.7	20.2	− 2.2
Salaries and wages	$ 66,987,669	$ 89,983,975	$ 68,736,763	−25.6	30.9	− 2.5
Revenue (operating)	$ 97,729,160	$159,682,419	$128,630,859	−38.8	24.1	−24.0
Taxes assignable to operations during the year	$ 4,033,821	$ 6,181,805	$ 5,572,704	−34.7	10.9	−27.6
Investment in plant and equipment	$415,694,458	$338,143,146	$254,029,933	22.9	33.1	63.6

* Exclusive of pole line owned and operated wholly by class I railroads and of pole line owned by ocean-cable systems reporting separately, amounting to 446 miles in 1932 and 2,089 miles in 1927.

† Exclusive of wire owned and operated wholly by class I railroads, amounting to 337,059 miles in 1932, 333,898 miles in 1927, and 285,002 miles in 1922; and of land wire owned by cable companies reporting separately, amounting to 5,923 miles in 1932, 7,211 miles in 1927, and 8,013 miles in 1922.

Source: United States Bureau of the Census: "Telephones and Telegraphs," 1932, p. 40.

telegraph system is one which provides facilities for the transmission of communications to a distant point where they are automatically recorded in typewritten form. Printing-telegraph machines resemble and are operated like typewriters, having keyboards, type bars, and platens similar to standard typewriters. Through the operation of keys on a sending machine, groups of electrical signals are sent over a wire; at the receiving station these signals operate apparatus which translates them into mechanical motion, resulting in the printing of the transmitted character.

Printing-telegraph equipment may be classified according to type of transmission and kind of reception, there being two general classes of each; namely, direct keyboard or tape transmission, and page or tape reception. In direct keyboard transmission, the depression of a key causes a corresponding sequence of impulses to be sent directly to the line. Tape, or automatic, transmission functions through the medium of a strip of perforated paper and transmitting mechanism. The tape is prepared on a perforator which punches various combinations of holes representing the desired characters. The tape is then passed through the transmitter and sends corresponding impulses to the line. The page printer records the message on a sheet of paper, and performs automatically practically all the functions of a standard typewriter. The tape printer is simpler than the page printer. It records its message on a narrow paper tape which is automatically fed through the machine as operation occurs. Either gummed or ungummed tape may be used. Printing-telegraph equipment may be arranged for simplex, duplex, or multiplex operation.

Multiplex systems with printing-telegraph equipment are economical only for dense traffic regions. They cannot supersede the key transmission of a scattered business distributed to many points on a local line. In such places, simplex operation is employed. In most of the small telegraph offices located in railroad stations, Morse operators are still employed. At present, however, more than 90 per cent of the total domestic telegraph business is handled by machines. The introduction of multiplex systems has saved the telegraph companies many times the expenditure for wire plant which otherwise would have been necessary. For example, during the 20-year period, 1910 to

1930, wire mileage of the Western Union increased only 12 per cent, but message capacity increased almost 10 times. But the changing over from manual to automatic operation has been a costly process in itself. The principal savings have resulted from the superior speed of machines and the fact that fewer and less-skilled operators are required to handle the volume of traffic.

Statistics are not available to demonstrate to a point of nicety the cost of changing from manual to machine operation, but the statistics of telegraph and cable companies reporting to the Interstate Commerce Commission indicate in a general way the effects of this change. According to the reports of these companies, investment in plant and equipment increased steadily, year by year, from $243,358,432 in 1917, to $411,725,366 in 1929, and to $465,639,421 in 1932, an increase over the entire period of 91.33 per cent. This increase represented for the most part the cost of conversion from manual to automatic operation, although a part was due to increase in wire mileage from 1,890,245 miles in 1917, to 2,336,976 miles in 1932, an increase of 23.63 per cent. The change from iron to copper wire also added to investment in plant and equipment. Copper mileage of the Western Union, for example, increased from 42 per cent of the total land-line wire mileage in 1917, to about 75 per cent at the present time.

During this same period, the number of messages handled increased from 158,176,456 in 1917, to 209,525,741 in 1929, only 32.46 per cent, and declined to 126,915,907 in 1932, a decline of 19.76 per cent from 1917. Operating revenues, which include payments for the use of private wires as well as revenues from public messages, increased from $106,989,743 in 1917, to $188,574,485 in 1929, an increase of 76.25 per cent, but declined to $110,302,414 in 1932, an increase over the entire period of only 3.09 per cent. Net operating revenues for the entire group, which were equal to 13.2 per cent of the investment in plant and equipment in 1917, declined to 7.9 per cent of the investment in 1929, and, in 1932, owing to the precipitous decline in gross earnings after 1929, to only 2.4 per cent of the investment. The ratio of total operating expenses to total operating revenues for these companies rose from 70 per cent in 1917, to 82 per cent in 1929, and to 89 per cent in 1932. These figures indicate,

roughly it is true, that investment in plant and equipment has become an increasingly heavy burden upon the telegraph companies, and that traffic must be considerably above its 1932 volume to earn a fair return upon the investment. It is significant to note that while traffic was declining after 1929, investment increased materially.

Private-wire Services.—In addition to the public telegraph service, the telegraph companies lease wires to individuals for their own private use. Such facilities are provided under contracts which provide that the company will furnish the customer a circuit for the transmission of messages between the points and offices named during the hours specified in the contract. The contracts also provide for the location of the terminals in the offices of the lessees, and for "drops" at intermediate points for service to parties associated with the lessees. A circuit is provided each morning at a stated time for the exclusive use of the lessee, who may then transmit messages through his own operators without interference by the telegraph company. Both of the telegraph companies and the American Telephone and Telegraph Company lease private telegraph circuits, the latter company leasing the by-product circuits obtained by superimposing telegraph circuits upon telephone-wire circuits. In the past, these circuits were operated by Morse operators, but with the development of telegraph printers and teletypewriters, these instruments have been utilized extensively on the private circuits.

The principal users of private circuits are bankers and brokers, for the transmission of orders and sales for exchange trading; newspapers and press associations; and industries for interdepartmental communications between general offices and branch offices, manufacturing plants, and distributing stations. Private-wire service is highly expeditious and economical. The principal advantages are: the facilities are always ready; messenger service is eliminated; a restricted vocabulary may be used which is adapted to the needs of a particular business, especially the use of technical terms; abbreviations may be used extensively; addresses and signatures may be eliminated; messages need not be in code, hence there is no need for enciphering and deciphering; greater proficiency in manual operation is attained by operators handling only one type of message, this

making for greater speed and accuracy; and greater secrecy is obtained.

Timed-wire Service.—In December, 1931, the Western Union and the Postal joined forces to render a new type of service to their printer-telegraph patrons. By arrangement between the two companies, any printer patron could be placed in direct communication with any other such patron of either company. The charge, for the first time in telegraph history, was based upon the amount of circuit time used, and not upon the volume of words. Although this arrangement between the telegraph companies has been terminated, timed-wire service as furnished by the companies separately competes with a similar service provided for its teletypewriter patrons by the American Telephone and Telegraph Company. The latter service, however, is a two-way communication service provided through a switchboard which enables interconnection among the teletypewriter users just as a switchboard does among telephone users. In printer installations and service, there is duplication among the three companies to a large extent. In the opinion of many, the teletypewriter or the telegraph printer would become the backbone of the telegraph service if the services were consolidated so that any teletypewriter or printer-telegraph patron could communicate with any other such patron, especially since the application of the teletypewriter exchange would bring about a record communication system similar to that in voice communications.

Supplemental Services.—The telegraph companies also have developed many services of a supplemental nature. These include: (1) market quotations and reports, baseball and other news furnished by messenger, private wire, or ticker; (2) money-order service; (3) messenger service at offices where messengers are employed for the delivery of notes, packages, samples, advertising matter, etc., on a distance or hourly basis, at rates depending on local conditions; (4) photogram service, covering facsimile transmission by wire of pictures and messages; (5) marine service, covering reports of sighting and arrival of incoming steamships; (6) air express and freight services for handling packages with messenger pickup and delivery door to door; (7) travel-check service, the Western Union handling American Express checks, and the Postal, A.B.A. checks; and other miscellaneous services.

The bulk of telegraph revenues come from the ordinary telegraph service, but some of the auxiliary or supplemental services have come to be important sources of revenue. Of the 1934 gross operating income of the Western Union, amounting to $87,230,000, about $68,000,000 came from ordinary telegrams, and about $5,919,000 from the transatlantic cables. Market reports contributed about $4,765,000; money orders, about $3,268,000; messenger service, about $1,961,000; leased wires, about $1,872,000; and timed-wire service, about $528,000.

Economic Characteristics.—The telegraph as a means of instantaneous communication between distant points is an indispensable adjunct of modern business. It is also an important means of communication for social purposes, although it is estimated that the social business, at least of the Western Union, constitutes only 10 per cent of its total volume.[1]

The telegraph service consists of the collection, transmission, and delivery of written messages for others by a specialized operating staff, the patrons taking no part in the service. A telegraph circuit, which at most consists of a pair of wires, due to the development of multiplex telegraphy and the use of telegraph "carrier" systems on wire circuits, has a capacity of many thousand messages for 24 hours. This makes the cost per message, due to plant charges, relatively small, although it increases with distance. However, the cost per message for the collection, transmission, and delivery is almost constant, varies little with distance, and is relatively a large part of the total cost per message. The large message cost for collection, transmission, and delivery, and the relatively small message cost due to plant, make the telegraph message expensive for short distances and relatively cheap for long distances.

Load factor, as in the operation of other utilities, has an important bearing on telegraph costs. The telegraph service was first developed as an expedited or immediate service. But the demand for such expedited service comes largely during the working hours of the day, since the telegraph is used principally for business purposes. The plant and operating facilities, however, must be at least sufficient to handle the average maximum demand for this class of service at any time; thus a

[1] Statement of Newcomb Carlton, Hearings on S.6, 71st Cong., 2d Sess., Part 11.

portion of the plant and operating facilities lie idle during certain hours of the day. Deferred, low-rate services have been introduced to develop telegraph traffic at off-peak hours and thus to improve load factor.

Telegraph costs are also affected by the volume of business. Within the capacity of the plant, and especially so far as the messenger services are concerned, the telegraph industry is one of decreasing costs, although when the capacity of the plant is reached, new business can be handled only by an increased investment, which raises the level of fixed charges. The nature of the service demands, consequently, have an important bearing on telegraph costs. New business coming at off-peak hours tends to improve the load factor, whereas new business of an urgent nature, that cannot be deferred, coming at peak hours, can be handled only at increased costs.

TELEGRAPH RATE MAKING

Telegraph rates are based principally upon distance, the length of the message, and the time at which the transmission is to take place. Distance is a factor in telegraph rate making because it costs more to transmit messages over great distances than over shorter ones, but total costs do not increase proportionately with distance. This is due principally to the fact that the costs of collection and delivery, the costs of installation and maintenance of terminal apparatus, and the costs of maintaining operating, clerical, and administrative personnel, which together make up a large part of total costs, are for the most part independent of distance. The time of transmission is a factor because of the necessity of providing facilities to handle the peak load which are largely unused during other hours of the day. Low charges for off-peak use are feasible and economically justifiable.

The length of the message, determining as it does the quantity of service rendered, is necessarily an element in telegraph rate making. Charges are based upon the number of words, with a flat charge for a minimum of 10 words for ordinary telegrams (50 words for letters) and additional charges for additional words. Minimum charges for telegraph messages are designed to cover, in part at least, other costs than those directly associated with the handling of a given message, but the determination of the number of words allowed under the minimum charge

is an important matter. If the minimum is too low, it discourages use of the telegraph; if it is too high, it affects unfavorably telegraph revenues, since much revenue comes from charges for words in excess of the minima allowed under the flat charge. The importance of this factor is recognized by the radio companies, whose radiotelegraph services compete with the wire telegraph companies between a few large cities in the United States. The rates for messages between the same points are the same as those of the wire companies, but the radio companies allow a 15-word minimum, as compared with the 10-word minimum of the wire companies.

Of great importance also is the matter of word count, especially in the body of the message, single addresses and signatures not being charged for in domestic telegrams. Rules governing word count are elaborate and detailed. In domestic telegrams, words may be taken from the English, German, French, Italian, Dutch, Portuguese, Spanish, or Latin languages and are counted as one word each, regardless of length. Dictionary words from other languages than those enumerated may be used in messages, but they are counted as one word for every five letters or fraction thereof. Similarly code words may be used, but all groups of letters, not dictionary words of the above eight languages, or combinations of such dictionary words, or proper names, are counted at the rate of one word for every five letters or fraction thereof. Combinations of two or more dictionary words, or mutilated dictionary words, written together contrary to the usage of the language, are counted according to the number of words of which they are composed. Proper names are counted according to the number of words and initials which they contain, except certain names of countries and political subdivisions, etc. Common abbreviations are counted as one word each, as are figures, decimal points, and bars of division, except quotation marks and parentheses which are counted as one word each. In groups consisting of figures and letters, each letter and figure is counted as one word, as are the affixes in ordinal numerals.

Telegraph companies at the request of the sender will take additional measures to ensure accuracy of transmission, or special handling at destination beyond the free-delivery limits of the terminal office, but the liability of a telegraph company

for mistakes in transmission, delay or failure in delivery, for ordinary messages was limited by a ruling of the Interstate Commerce Commission to $500. . Upon payment of an additional charge equal to one-half the regular rate, the sender may have his message repeated back to the original office, and the liability in such cases has been fixed at a maximum of $5,000. If the sender believes that error or delay will occasion greater loss than $5,000 he may place a value upon the message and hold the company liable up to and including the stated value. The charge for this service is 1½ times the regular rate plus a charge of one-tenth of 1 per cent of the amount by which the valuation exceeds $5,000. For a special charge, a sender may have sent back a report of delivery of a message.

Classes of Service. 1. *Telegrams.*—Telegrams represent the full-rate expedited service. The rates for telegrams are determined by the application of square or state rates, which will be explained later. They comprise a minimum initial rate for 10 words or less, with an extra charge for each additional word.

2. *Night Messages.*—Night messages are accepted up to 2 A.M. at reduced rates, to be sent during the night and delivered not earlier than the morning of the ensuing business day. Night messages may, at the option of the telegraph company, be mailed at destination to the addresses. .

3. *Day Letters.*—Day letters constitute a deferred day service at rates lower than the standard telegram rates, the rates being 1½ times the standard night-letter rate for the transmission of 50 words or less and one-fifth of the initial rate for each additional 10 words or less. Day letters may be forwarded by the telegraph company as a deferred service and the transmission and delivery of such day letters are, in all respects, subordinate to the priority of transmission and delivery of regular telegrams.

4. *Night Letters.*—Night letters are accepted up to 2 A.M. for delivery on the morning of the ensuing business day, at rates still lower than standard night-message rates. The standard telegram rate for 10 words is charged for the transmission of 50 words or less, and one-fifth of this rate for each additional 10 words or less.

5. *Press Service.*—Press business is handled at special low rates (for day press messages, one-third of what the tolls would be on the same message at full commercial day rates, and for

night press messages, one-sixth of that amount). Press rates apply to news dispatches, queries, and orders. Messages offering news or articles for sale, or quoting a price for news or articles, or accepting or rejecting an offer of news or articles offered at a stipulated price, or specifying a price at which news or articles will be accepted, are declared business messages and pay full rates.

6. *United States Government Messages.*—Rates for the transmission of official messages for the United States government until recently have been fixed by the Postmaster General, usually at 40 per cent of regular tolls. Government day messages have priority in transmission and delivery over all other messages. Government day letters are subordinate to full-paid commercial traffic but have priority over commercial day letters.

7. *Volume Discount Rates.*—Except in a few services there are no wholesale rates in the telegraph service. Charges in the general public service are based on the message, and the charge is always the same for the same class of message of the same length over the same route, regardless of the number of messages submitted. In a case some years ago, it was contended before the Interstate Commerce Commission that private-wire service was a wholesale service, the effect of which was to give lower rates for telegraph service to those having sufficient business to justify the use of private wires, to the prejudice of those having to use the public wires because the total cost was so high that only those with a large business could secure the benefits of private wires. The Commission, which had jurisdiction over the rates and classifications of interstate telegraph communication, while stating that the wholesale theory has no proper place in the rates of common carriers, held that the private-wire service was not a wholesale service. The companies, the Commission said, held themselves ready to serve all applicants to the limit of their facilities, the rate was based on mileage, not on volume of business, and there was no minimum-mileage restriction; hence, the classification was a just and reasonable one. Regarding differences between the public telegraph service and private-wire service, which justify a separate classification, the Commission quoted from a statement of the American Telephone and Telegraph Company as follows:

The telegraph company undertakes to collect the telegrams either over the local telephone or by messenger, collects the charge for transmission either from the sender or the addressee, or, in lieu thereof, makes a record through its bookkeeping department, handles the telegram over its counter through its recording clerks, passing the same to its operators by means of messengers, transmits the telegram over the wire to the distant point, sometimes after several relays, and there, after making a copy of the telegram and making the proper entries upon its books, delivers the telegram by messenger to the person addressed. The very telegram itself, instead of containing only the words of the message desired to be conveyed to the addressee, usually has eighteen to twenty additional words or characters identifying the sender, his address, the date of sending, the addressee, his address, the time of sending, the time of receiving, the operator sending, the operator receiving, the number of the telegram according to the files of the sending office and the same of the receiving office, the sending marks of the operator at either end, the check of the number of words, information as to whether or not the charge for the telegram has been paid or is to be collected from the addressee, and other necessary information to complete the records of the company. In addition to all of this the telegraph company maintains its own offices, pays for its own light, heat, counter clerks, cashiers, managers, stationery, messengers, and other overhead expense, and assumes under the law full legal responsibility for all errors or delays in transmission. In the case of the leased-wire service the telegraph company does nothing except furnish the wire, telegraph instruments, and electric current. The user furnishes everything else and assumes full legal responsibility for any errors made, as well as all expenses of operation.[1]

The introduction of serial service and timed-wire service, however, is a distinct experiment in the application of the principle of graduated volume discounts, as practiced by virtually all industry, to the making of telegraph rates.

A serial is a message filed in sections, all sent on the same day from the same sender at the same office of origin to the same addressee at the same address. Serial service is a deferred service, subordinate to full-rate telegrams in transmission and delivery. The telegraph company may send the sections at its convenience and may at its option combine them in transmission and in delivery, or either. The minimum charge is for 50 words on any one day. The charge is based on the total number of words in the sections of a series, except that no section is

[1] *Private Wire Contracts*, 50 I.C.C. 731, 762.

rated as containing less than 15 words. The rate for the first 50 words is one-fifth more than the rate for a 50-word day letter, rounded out to multiples of 5 cents; and the rate for each additional 10 words or less is one-fifth of the rate for the first 50 words. The sender, when filing the first section of a serial, must indicate that he wishes this class of service and having so indicated, he will be charged at least the minimum toll for one serial.

The charge for timed-wire service is based upon the amount of time consumed in transmission, rather than upon the volume of words, and the service is available over the printer lines of both the Western Union and Postal companies. The charge generally is twice the full-rate-telegram charge for 10 words for an initial period of 3 minutes, and an additional charge for each extra minute of one-third the initial-period rate. In the serial service four messages may be sent for less than four times the cost of one; and in the timed-wire service, depending upon the speed of the communication, more than 100 words can be sent for about 50 per cent more than the cost of a 10-word telegram.

The Telegraph Rate Structure.—The telegraph rate structure is not a scientific one in many respects. Rates vary only roughly with distance, and only roughly with cost. For example, there are only nine possible prices one can pay for a standard 10-word telegram from one point to various other points in the United States, yet the cost of handling a message may vary from a few cents to several dollars, although there is no way by which a telegraph company may calculate the exact cost of a single message because of a multitude of variables and the uncertainties of cost allocation. The rate structure, like railroad rate structures, has been influenced by many historical factors of tradition and community rivalry.

The task of computing distances from each telegraph office to every other office would be a tremendous one and would not repay the expenditure necessary. Some plan of grouping, therefore, necessarily was adopted. The zones adopted by the telegraph companies are territorial and conform to state boundaries. Rates vary with distance, but owing to the fact that zone boundaries conform to state boundaries the rates are only roughly proportional to distance and many discriminations occur.

However, such discriminations are less important in the telegraph industry than in the case of other common carriers, the telephone, for example, because distance is a relatively less important cost factor.

The telegraph rate structure presented here is that of the Western Union, the Postal Telegraph having a similar structure. Western Union rates and Postal Telegraph rates are the same for interstate business. In some 10 states intrastate rates are the same for both companies, but in the other states Western Union rates are about 20 per cent higher than Postal rates.

The rate structure of the Western Union is based upon two types of rates: (1) state rates and (2) square rates. The two types are not mutually exclusive, since one may merge into the other.

1. *State Rates.*—Each state has a single fixed rate to each other state. This rate applies from all points in the state of origin to all points in the state of destination, except as modified by the square rates. Each state has also a fixed maximum rate for intrastate messages, which applies between all points within the state of origin except as modified by the square rates.

2. *Square Rates.*—To provide suitable rates for the shorter distances, lower than the state rates, each telegraph office is surrounded by an area in which such lower rates, graduated to distance, prevail. For this purpose a system of squares is used, measuring 50 miles on each side. The entire United States is laid off in such squares, arranged in staggered or brick fashion, and numbered from north to south and from east to west. The square rates are as follows:

a. To a point in the same square in which the originating office is located and to all points within two squares of the square in which the originating office is located—30 cents for 10 words or less and 2½ cents for each additional word.

b. To points in the next encircling tier of squares (*i.e.*, in squares that are three squares distant from the square in which the originating office is located)—36 cents for 10 words or less and 2½ cents for each additional word.

c. To points in the next encircling tier of squares (*i.e.*, in squares that are four squares distant from the square in which the originating office is located)—48 cents for 10 words and 3½ cents for each additional word.

In all cases the lower rate prevails, whether determined by the application of state rates or square rates; *i.e.*, the rates as determined by squares supersede the state rates whenever they are lower than the state rates, and whenever the state rate is as low as or lower than the square rate, the square rate becomes merged in the state rate and disappears, the state rate governing. For example, the state rate from New Jersey to Virginia is 60 cents, but the square rate from square 47 in New Jersey (around Princeton) to each of several squares in northeastern Virginia is only 48 cents; thus the latter rate supersedes the state rate. Again, Oklahoma has a maximum intrastate rate of 48 cents, yet many points in Oklahoma lie beyond the fourth encircling tier of squares as measured from square 566, located in the northeastern corner of the state. Thus, the square rates become merged in the state rate and the latter governs. Rates for all other classes of messages are based upon the rates for ordinary telegrams.

The calculation of rates by telegraph employees is a simple process. Each office is supplied with a tariff book and supplements, and a particular rate sheet. The tariff book does not show the rates from one point to another, nor the state rates or square rates, but shows the square number of each office and, of course, the state in which it is located. On the rate sheet, at the right-hand side, appear state rates from the state in which the particular office is located. At the left-hand side appear columns of square numbers indicating the squares to which square rates apply from the square in which the particular office is located, and over each column the square rate to the squares whose numbers appear below it. When a message is presented for transmission, the office where it is filed consults the tariff book, ascertains the square number of the office of destination, and looks at its rate sheet to see if there is a square rate to that square. If the rate sheet shows no square rate, the state rate is charged; if it shows a square rate, the square rate and state rate are compared and the lower of the two rates is charged.

3. *Special Rates.*—In addition to the state rates and square rates, many special rates are in existence lower than the corresponding state and square rates, which govern traffic between various points, the majority of them centers of importance. These do not conform to the general structure, and have mostly

an historical explanation. Prior to 1888, a large number of special rates were in existence, representing early adjustments to suit conditions of competition and jealousy between rival communities. About 1905, the Western Union began to eliminate such rates and many were brought up to the level of appropriate square or state rates. But many still exist, and they constitute sources of unjust discrimination; however, they have become so firmly embedded in practice that their elimination would present a difficult practical problem.

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CHAPTER XIII

CABLE COMMUNICATION

Transatlantic Cable Systems.—The first successful trans-oceanic cable connecting the United States with foreign nations was laid in 1866 through the ingenuity and perseverance of Mr. Cyrus W. Field. It was not an American cable, but was laid by a British company, the Anglo-American Telegraph Company, and financed almost wholly by British capital. British interests assumed an early leadership in cable laying and they remain today the principal national group in terms of cable mileage. There were several reasons for the early leadership of the British: (1) there was an abundance of capital available in England; (2) the British were interested in cable development because of its political significance and its importance to the conduct of their widespread commercial and shipping enterprises; (3) they controlled the early supply of gutta-percha, the only completely satisfactory insulating material for cables; and (4) they early developed an organization for the manufacture and maintenance of submarine cables, cable manufacture being a highly specialized undertaking, and the manufacturing companies became interested in the promotion of cable enterprises. The success of the first cable led to the laying of others soon thereafter. A second British company, the Direct United States Cable Company, laid a cable between Ballinskellig Bay, Ireland, and Torbay, Nova Scotia, with a cable from Torbay to Rye Beach, New Hampshire, in 1874; and the French entered the trans-atlantic-cable field with a cable from Brest to St. Pierre, and thence to Cape Cod, Massachusetts, in 1879.

The first American-owned transatlantic cables were laid by the American Telegraph and Cable Company, in 1881 and 1882, through capital supplied largely by Mr. Jay Gould. Two cables between Bay Roberts, Newfoundland, and Penzance, England, were laid, which were leased to the Western Union Telegraph Company in 1882. About this time Mr. John W. Mackay

and Mr. James Gordon Bennett entered the cable business, the latter as editor of the *New York Herald* being one of the largest cable users of the time. They organized the Commercial Cable Company and laid two cables from St. John's, Newfoundland, to Waterville, Ireland, which were opened for traffic in 1884. This led immediately to a rate war between the Commercial Cable Company and the cable pool previously established by the other transatlantic companies which was settled only by including the Commercial Cable Company in the general agreement. The chief handicap of the Commercial Cable Company was its lack of land-line facilities, necessary to reach interior points. It had the choice either of making contracts for the interchange of traffic with land lines, in which case it would have been obliged to negotiate with its competitor, the Western Union, or of building up its own domestic telegraph system. It chose the latter course, as we have seen, and set up the Postal Telegraph system, which expanded rapidly and soon reached most of the important points in the United States. To these American cables were added others and the American systems were extended by both construction and lease. In 1911, the Western Union leased the entire cable system of the Anglo-American Telegraph Company, five cables in all, and from 1924 on, laid three additional transatlantic cables, making a total of ten cables in its transatlantic system. The Commercial Cable Company altogether has laid six transatlantic cables.

Germany had no direct cable connection with the United States until 1900, in which year a cable was laid from Emden, Germany, to New York, via the Azores. This was followed by a second cable in 1904. At the beginning of the World War both these cables were cut in the English Channel, one being landed by the British at Penzance, England, the other by the French at Brest. On this end, the British landed the cable which they appropriated in Halifax, Nova Scotia, and the French landed theirs in New York. Direct cable communication with Germany was not restored until long after the war, when by arrangement between a German company and the American companies, the former laid a cable from Emden to the Azores where it was connected with a Western Union cable from the Azores to the United States, operated in separate channels by the Western Union and Commercial Cable companies. This

cable was opened to the public in 1927. Direct cable communication between Italy and the United States was established for the first time in 1925, through connection at the Azores between an Italian cable company and the American companies.

At present there are two American companies operating in the transatlantic-cable field, the Western Union Telegraph Company and the Commercial Cable Company, a member of the system of the International Telephone and Telegraph Company. The Western Union system consists of ten cables, five owned or controlled by the Western Union and five operated under lease from the Anglo-American Telegraph Company. Two of these cables run to the Azores, where one connects with a German cable, and the other with an Italian cable. For collection and delivery of messages in North America it has its own extensive land-line system in the United States, a controlling interest in the Mexican Telegraph Company, and connections for the exchange of traffic in Canada with Canadian National Telegraphs, as well as title to land lines set apart for through connection between its system in the United States and its cable stations in Canada and Newfoundland. It has about 25 offices in Great Britain and connections in London with the Eastern Telegraph Company and its associated companies, and with the Great Northern Telegraph Company of Denmark. It has offices in Paris and Havre, France, and in Holland and Belgium.

The Commercial Cable Company owns and operates six cables between New York and England. All of these touch at either Nova Scotia, Newfoundland, or Ireland, en route to England. Two of them touch also at the Azores before reaching Ireland. The Commercial Cable Company also has two cables between Ireland and France. In addition to these, it leases from the Western Union two of the five channels developed in the latter's New York-Azores permalloy cable. Its land-line connections in North America consist of the Postal Telegraph system, the Canadian Pacific Railway Company, which operates an extensive telegraph system in Canada, and the Newfoundland Government Telegraphs. Like the Western Union, it has offices in Europe and connections for traffic with countries in Europe, Asia, and Africa. It connects also with the Halifax and Ber-

mudas Company and the Direct West India Company (both British) for Bermuda and the West Indies.

The American companies are in competition with two foreign cable systems, the British Imperial System (now a part of the British cable-radio merger—Imperial and International Communications, Ltd.), and the French Cable Company. The former owns and operates two cables, one a former German-owned cable. The total length of the system is about 6,400 nautical miles. The latter owns and operates three cables, one of these being also a former German-owned cable. The total length of this system is about 10,444 nautical miles.

Of the total transatlantic-communications business, the American companies carry by far the greatest volume. The division of traffic in 1929, as stated by Mr. Newcomb Carlton, was as follows: Western Union, 44 per cent; Commercial Cable Company, 29.5 per cent; the French cables, 7 per cent; the British cables, 2.9 per cent; British radio between Great Britain and Canada, 1.8 per cent; R.C.A. Communications, Inc., and the British radio, 3.5 per cent; and R.C.A. Communications, Inc., all European radio business except Great Britain, 10.2 per cent.[1]

Cable Communication between the United States, the West Indies, Central and South America.—British interests also were the pioneers in cable communication to the West Indies and South America. The first company, the West India and Panama Telegraph Company (a British company, later absorbed by the Cuba Submarine Telegraph Company, now a part of Imperial and International Communications, Ltd.) laid a series of cables in the West Indies, beginning about 1870. This system at first was connected with the United States and thus Great Britain by a cable from Havana to Florida, but later cables were laid to connect this system with Canada. In South America, the pioneer British company was the Western Telegraph Company. This company obtained an inter-port monopoly from the Brazilian government which hampered for a long time the development of American cable communication to and from Brazil.

Mr. James A. Scrymser was chiefly responsible for the early development of cable communication between the Americas by

[1] Statement of Newcomb Carlton, Hearings on S.6, 71st Cong., 2d Sess., Part 11, p. 1464.

American companies. His interest was first in Cuba, but in 1868, Mr. Seward, then Secretary of State, attempted to obtain from the government of Brazil a concession for Mr. Scrymser to lay a cable direct to Brazil, this attempt being defeated by the British interests which later organized the Western Telegraph Company. In 1873, the latter company obtained a 60-year monopoly whereby no other concessions for the laying of submarine cables to connect two or more of the most important political subdivisions of Brazil could legally be granted.

Failing in this attempt Mr. Scrymser organized two companies: one, the Mexican Cable Company, to establish cable communication between the United States and Mexico, land telegraphic connection being unsatisfactory; and the other, the Central and South American Company, to develop communication to Central and South America. Beginning about 1881, cables were laid which eventually connected the United States with Mexico, the Central American countries, and the countries on the west coast of South America. But the principal problem of the growing Central and South American Company was that of getting into Brazil where the bulk of South American cable traffic originated, or to which it was destined. It extended its cables down the west coast to Valparaiso, Chile, and purchased the Transandine Telegraph Company, which operated between Chile and Argentina, with the object of laying cables from Argentina to Brazil, thus circumventing the monopoly of the British company.

The latter attempt also was frustrated by the British company, which obtained from the Brazilian government, in 1893, a 20-year monopoly of cable communication between Brazil and Uruguay and Argentina. The American company attempted to carry messages between Brazil and the United States over the lines of the British company as far as Buenos Aires, but this was made unprofitable by the British company by the application of additional charges for the transmission of such messages. The American company was unable to reach Brazil directly by its own lines until 1919, after the expiration of the second monopoly grant to the British company, and after a long suit in the Brazilian courts had been decided in its favor. The inter-port monopoly of the British company was still in effect, however, and the American company was compelled to lay two

cables from Argentina, one to Santos, and the other to Rio de Janeiro, which paralleled each other most of the distance. At this time the name of the company was changed to All America Cables, Inc.

The entry of All America Cables, Inc., into Brazil created a highly competitive situation. Its more direct route threatened to take from the British company much of the latter's traffic between North and South America, this traffic having to go by way of the Azores where connection was had with the Commercial Cable Company. The British company realized the need for a direct route, and it began negotiations with the Western Union Telegraph Company for a connection, the latter company also being desirous of sharing in the South American traffic, especially since expansion of our trade relations with the South American countries was anticipated. An attempt was made to bring the three companies together on some agreed basis of territory or traffic division but without success. Thereupon negotiations were completed between the Western Union and the Western Telegraph Company and an agreement arrived at whereby the former laid a cable from Miami, Florida, to Barbados, and the latter from Barbados to Brazil. A license to land this cable in the United States was withheld for several years by the President, but in 1922 it was opened to the public. Since that time the Western Union, which formerly interchanged traffic with All America Cables, Inc., has turned over its South American traffic to the British company at Barbados, except for points reached only by All America Cables, Inc.

Thus there are two American companies engaged in cable communication between the Americas, the Western Union and All America Cables, Inc. Since 1928, All America Cables, Inc., has operated, besides its own lines, those of the French Cable Company in the West Indies, and those of the United States and Haiti Telegraph and Cable Company, an American company. It is now a part of the International Telephone and Telegraph system, and through coordination with the cables of the Commercial Cable Company at New York, it has been enabled to obtain a large share of the South America-European cable traffic. Before the World War most of its business was between the Americas; today the most of it is with Europe. It controls also Cuban All America Cables, Inc., which has one cable between

New York and Havana, and one between Miami and Havana. In addition, the Western Union operates three cables to Cuba and the West Indies, and two to Mexico.

Besides the cables of the Western Telegraph Company, there are cables of the French and Italian companies between Europe and South America. The former has a cable which runs from Dakar, in Africa, where it connects with lines between Senegal and France, to Pernambuco. The cable of the Italian company runs from Anzio, near Rome, via Malaga, Spain, to the Canary Islands, and thence via the Cape Verde Islands to Rio de Janeiro and Buenos Aires. Before the war the Germans had established an important cable route from Emden, via Teneriffe, to Monrovia, Liberia, and thence to Pernambuco. After the war the northerly portions of this cable were used by the French to provide cables between Brest and Casablanca and Dakar. The Monrovia-Pernambuco section has never been brought back into use.

Transpacific Systems.—No cables were laid under the Pacific Ocean until the beginning of the twentieth century, although several projects had been contemplated. About 1900, interest in a cable to connect the United States with the Orient became intense because of the political situation created by our newly acquired possessions in the Pacific, and commercial interest in the development of American trade in the Far East. The chief obstacles were the great distances to be covered through unproductive territory, the great depths in which the cable would have to be laid and repaired, and the difficulties to be encountered in getting into Japan and China because of foreign concessions and monopolies. Up to that time, telegraphic communication with the Orient had been over the lines of the Great Northern Telegraph Company, a Danish company, and those of the Eastern Telegraph Company and its subsidiary, the Eastern Extension, Australasia and China Telegraph Company, both British. To make the cable venture a profitable one, it would be necessary to obtain traffic to and from Japan and China, but this was prevented by monopolistic concessions made by the governments of these countries to the British and Danish interests. Several bills were introduced into Congress proposing that the United States government lay such a cable but all failed of passage. Eventually the Commercial Pacific

Cable Company was organized by the Mackay interests, and the laying of a cable was begun in 1902. Concession was made to the British and Danish interests in the form of participation in ownership. The cable is owned 25 per cent by American interests, 25 per cent by the Danish, and 25 per cent each by the two British companies. The cable runs from San Francisco to Honolulu, to Midway Island, to Guam (where a branch runs to the Bonin Islands to connect with a Japanese cable), to the Philippines, and to Shanghai.

The only other cable across the Pacific is that of the Pacific Cable Board, now a part of Imperial and International Communications, Ltd., laid in 1902. The laying of this cable was a joint undertaking by the governments of England, Canada, Australia, and New Zealand. The United States government owns a cable running from Seattle to Alaska, but with the development of radio communication it has practically fallen into disuse.

Summing up, there are 29 submarine cables which connect the shores of the United States with foreign countries; 19 to Europe, 9 to the West Indies, Central and South America, and 1 to the Orient. These cables carry about 80 per cent of the entire foreign telegraphic communications of the United States, about 20 per cent being carried by radio. In 1933, the cable systems of the principal countries engaged in cable communication aggregated some 316,284 nautical miles. Census figures for ocean-cable systems, for the years 1922, 1927, and 1932, are presented in Table 38.

The mileage of ocean cable, volume of messages, and income from cable traffic of the American companies as a whole increased steadily until the end of 1929, since when there has been a marked falling off in messages and revenues due to the precipitous decline in world trade. United States Bureau of the Census figures show that from 1907 to 1927 nautical miles of cable owned and operated by American companies increased more than 128.7 per cent; the number of messages, 138.1 per cent; and income from telegraphic traffic, 144 per cent. In 1928, the volume of traffic transmitted over the ocean cables of the Western Union was greater than in any previous year, cable revenues being 5.7 per cent greater than in 1927; the paid words handled over the Commercial Cable system increased 13 per cent over

1927; and the number of messages of All America Cables, Inc., increased 7.4 per cent over 1927. In 1929, the American cable companies reported the greatest volume of business for any one year. The volume would have been even greater had it not been for the fact that a severe earthquake in the Atlantic in November of that year caused 24 breaks in 12 cables south of Newfoundland. Cable revenues of the Western Union increased 9.6 per cent over 1928; paid words of the Commercial Cable

TABLE 38.—SUMMARY, OCEAN-CABLE TELEGRAPH SYSTEMS, 1932, 1927, AND 1922

(Percentage not shown when base is less than 100)

Item	1932	1927	1922	Percentage of increase (– denotes decrease) 1927–1932	1922–1927	1922–1932
Number of companies or systems	6	7	6			
Nautical miles of ocean cable*	96,468	99,074	76,711	– 2.6	29 2	25.8
Cable offices	146	136	140	7 4	– 2 9	4 3
Messages sent	10,436,613	13,986,939	9,602,559	–25 4	45.7	8.7
Employees	5,790	6,595	6,333	–12 2	4 1	– 8.6
Salaries and wages	$ 6,961,254	$ 9,536,382	$ 7,425,163	–27 0	28.4	– 6.2
Revenue (operating)	$16,926,536	$17,906,677	$18,174,356	– 5.5	– 1 5	– 6.9
Taxes assignable to operations during the year	$ 393,177	$ 882,740	$ 1,321,290	–55.5	–33.2	–70.2
Investment in plant and equipment	$90,750,968	$88,555,596	$72,631,927	2 5	21.9	24.9

* In addition, the cable companies reported 5,923 miles of single wire on land and underground for 1932; 7,638 miles of such wire for 1927; and 8,013 miles for 1922. (Miles of pole line owned by ocean-cable systems, 1932, 446, and 1927, 2,089.)

Company, slightly less than 19 per cent; and messages of All America Cables, Inc., about 14 per cent. During the years 1930 to 1932, inclusive, cable revenues declined sharply, due to the relative inactivity in the security markets and the low volume of international trade. In 1933 and 1934, most countries of the world experienced substantial improvement in internal business activity, but international trade, due to exchange-control restrictions, high tariffs, and numerous other obstacles, continued at a very low level. The dollar volume of merchandise exports and imports of the United States declined from $9,641,000,000 in 1929, to $2,934,000,000 in 1932. The total dollar

volume rose slightly in 1933 and 1934, but the volume for 1934 ($3,788,000,000) was still only about 39 per cent of the 1929 volume.[1] Such variations in the international trade of the United States are directly reflected in cable earnings.

Technical Development.—Throughout the history of cable communication, many technical improvements have contributed to the efficiency and economy of cable operation. Improvements in terminal apparatus have been continuous and numerous, while fundamental inventions have revolutionized cable construction. Especially significant are the advances made since the World War in view of the development of competitive radio communication. The first of these that might be mentioned is the development of the automatic relay. Prior to 1918, transatlantic cables were worked sectionally by manual relay; that is, messages were recorded and resent by operators at various cable stations between New York and London, such as Nova Scotia, Newfoundland, Ireland, or Cornwall, and sometimes at all four points.[2] In 1918, automatic relay was perfected in the transatlantic service, and since then it has been applied in other sections of the world. The saving of time which this development has effected, as well as the reduction in labor costs, has been of immense significance to the cable industry.

A second development is that of permanently, or inductively, loaded cables. Before 1924, improvements in the speed of cables were limited to increasing the size and weight of the copper conductor. In that year, however, the Western Union laid a cable between New York and the Azores constructed upon an entirely new design, applying a separately wound metallic tape composed of a totally new alloy, called "permalloy." Since then the Western Union has laid two other transatlantic cables of this type. The importance of the new type of cable is the great speed at which it may be operated, thus greatly increasing capacity. Such cables may be channeled; that is, they may be operated in several circuits. Cables have long been adapted to duplex working, two simultaneous messages being sent, one

[1] U. S. Department of Commerce, "Summary of United States Trade with World," 1934, p. 11.

[2] COGGESHALL, I. E., Submarine Telegraphy in the Post-War Decade, an address presented at the Winter Convention of the A.I.E.E., New York, Jan. 27–31, 1930.

in each direction; but the new type of cable provides several high-speed circuits. In the New York-Azores cable of the Western Union, for example, five circuits have been developed. Each of the permalloy cables of this company has a capacity greater than the combined capacities of its seven cables of older design. No other American company has laid a transoceanic cable of the new type.

A third development is that of direct operation. To meet the increasing demand for faster communication service between Europe and America, American cable companies have developed and applied equipment whereby cable circuits may be extended directly to land-line points, thus eliminating manual relay at the cable stations. At present messages may be sent from most of the large cities in the United States direct into London, or Paris, or to other European points, without human relay. A fourth development is the application of telegraph printers, first developed on the land lines, to cable operation. The printer has been adapted to loaded and nonloaded cables.

Economic Characteristics.—Cable communication is dependent for the bulk of its revenues upon business operations; thus when international trade increases or declines cable revenues are directly affected. The relative proportions of business and social messages are not the same for all companies, however, since social messages come mostly from travelers and tourists. The traffic of All America Cables, Inc., consists almost wholly of business and news communications, whereas the transatlantic business of the Western Union is divided about 81 per cent business and 19 per cent social, this reflecting in a general manner the main routes of tourist travel. The principal business customers of the cable companies are the press, importers and exporters, brokers for banking and insurance firms, speculators in commodity and stock exchanges, and government officials.

Cable communication is a highly competitive industry. American companies compete with each other and with foreign companies on parallel or alternate routes. Cables also compete with the radio, the newcomer in the field of transoceanic telegraph communication, which in spite of the handicap of the lack of land-line facilities of its own, as is true of the Radio Corporation of America, has become firmly entrenched. Adequate land telegraph facilities are vital to the success of an

international communication system, whether cable or radio, since no successful enterprise could be developed solely on the traffic between coastal points.

The cable industry is one of decreasing costs, due to the fact that a large proportion of total costs are constant regardless of the volume of traffic. A large part of total costs are associated with the cable itself. The cost of a cable varies with many factors, such as the size and weight of the copper core, the amount of gutta-percha needed for insulation, and the amount and type of the protective covering. The cables of older design show a steady increase in the size of the copper core with the relative recency of their laying, the largest of all being in the cable laid in the Atlantic, in 1923, by the Commercial Cable Company. The copper core of this cable weighs 1,100 lb. per mile, as compared with some 350 to 650 lb. per mile of older cables. The amount and type of protective covering vary with the nature of the ocean floor to be encountered and is not so heavy for the deep-sea lengths as for the shore ends. Risk of breakage at depths of one or two miles is not very great, the principal dangers being volcanic movements, elevations and subsidences. Near the shore a cable is subject to the hazards of abrasion from rocky bottoms and breakage by fish trawlers and anchors. The laying of the cable requires great skill and the use of much specialized equipment. A certain amount of slack, sometimes as much as one-tenth of the distance between the points connected, must be allowed to ensure that the cable will lie snugly on the bottom of the ocean, and to enable the cable to be raised for repairs without being broken. Cables have become more costly as they have become better and faster. The transatlantic cables which were laid prior to the World War, and most of the cables were laid before then, cost on the average close to $1,000,000 per thousand miles.[1] The three permalloy cables of the Western Union cost in the aggregate about $25,000,000.[2]

An important factor affecting the costs of laying a cable between distant points is the fact that the speed of a cable

[1] Statement of W. A. Winterbottom, Hearings on S.5201, 72d Cong., 2d Sess., p. 54.

[2] Statement of Newcomb Carlton, Hearings on S.6, 71st Cong., 2d Sess., Part 11, p. 1489.

varies inversely with the square of its length. This means that the number of messages a cable can carry, and hence its earning capacity, decreases as the length increases. For this reason cables must be brought up frequently and "freshened" at intermediate points where messages are relayed. This explains why most of the cables between the United States and Europe touch at Newfoundland or Nova Scotia. Political considerations often enter into the determination of relay points and often affect adversely cable costs or revenues. Thus, when the route of the British cable in the Pacific was being considered, economic considerations pointed to a relay somewhere in the Hawaiian Islands but since this was American soil, it was decided to relay at Fanning Island, a British possession, 3,458 nautical miles from Vancouver. This is the longest unrelayed section of cable in the world; the speed of the cable is limited accordingly. Similar considerations were responsible for the routing of the Commercial Pacific cable via Midway Island in order to make of it an all-American cable. A more economical route would have been through the Marshall Islands, but the relay would have been on foreign soil.

Repairs are important from their effects both upon costs and upon gross revenues, since a cable is successful only with long, continuous use. A break often may mean not only loss of revenue during the time in which repairs are being made but loss of patronage to competitors. Much repair work may be evaded by careful routing of the cable when it is laid to avoid the dangers of chafing against rocky bottoms, especially in coral regions, moving ice, volcanic disturbances, etc. Sometimes a longer route is taken to avoid excessive maintenance costs. For instance, the shortest route between the United States and Japan, by some 3,000 miles, is along the great circle by way of the Aleutian Islands. This route actually had been considered by several different parties before a cable was laid across the Pacific, but the likelihood of frequent breaks due to the volcanic nature of this region, and the difficulties of making repairs under the unfavorable weather conditions which prevail for the greater part of the year, cast the balance in favor of a longer, but more southerly, route.

Load factor also affects cable costs. The characteristics of the cable load in many cases reflect a time differential. There is,

for instance, a difference of five hours between New York and London time, consequently, only a few hours of the business days in these two places overlap. As one moves westward through the United States, the amount of overlapping decreases until at San Francisco there is none at all. Similarly, there is no overlapping of the business hours in New York and the Orient. The bulk of the high-speed, full-rate transatlantic traffic comes during a few hours of the day, thus leaving facilities and personnel partly unoccupied during other hours of the day. The peak of Western Union transatlantic cable traffic comes during the hours from 9:30 A.M. to 3:30 P.M., New York time. Before 9:30 A.M. there is a considerable volume of westward traffic, but a diminished volume eastward. After 3:30 P.M. there is a marked decline in the volume of both westward and eastward traffic. There is a rise to a secondary peak around 5 P.M., due to the sending of daily résumés of business activities, and the load continues at a fairly high level until midnight, due to the clearing of delayed traffic. After midnight there is a decline until westward traffic begins to come in considerable volume. Westward traffic in the early morning hours consists of messages sent in anticipation of the opening of New York markets, exchanges, and business offices.

CABLE RATE MAKING

Cable rates, like telegraph rates, are based upon distance, the length of the message, and the time at which transmission takes place. Cable rate making is subject to the rules and regulations of the International Telecommunication Convention, which govern international telegraph communication throughout the world. The government of the United States is not signatory to the telegraph regulations of the Convention and, as a consequence American cable companies are not bound formally by its rules and regulations. However, in actual practice, American cable companies do business in or connect with companies or administrations in countries which are signatory, and for the most part they are forced to adhere. In all essential details they conform to the international rules and regulations, except those relating to charges for the performance of their own services, the transmission of the time of filing of messages, the making of multiple copies of the same telegram, and the recognition of "vias."

As regards the transmission of the time of filing of a message, the American companies hold that it would be a waste of cable space with a large percentage of messages, and that where it is necessary to the transaction referred to in the message, it should be included in the body of the message and charged for. The making of multiple copies of a telegram, they hold, would have the effect of practically turning the telegraph office into a copying bureau for the distribution of matter which should properly be handled by the agent of the sender. Such a provision would in effect compel them to become agents of any persons or concerns without their consent. With respect to the recognition of "vias," they hold that the enforced recognition of the routing prescribed by the sender would compel a private enterprise to place the use of its property at the service of competing concerns on the same terms as it is employed for the business of the owner himself. To demand recognition of the "via" without special considerations is to handicap the cable system with land connections and to favor the one without.[1]

Classes of Service. 1. *Full-rate Cablegrams.*—These messages constitute the regular expedited cable service. They pay full rates and are transmitted in the order in which received subject only to the priority of "urgent" and government telegrams.

2. *Urgent Messages.*—Practically all cable companies and administrations offer an urgent service, for which rates twice the full cablegram rates are charged. These messages are subject to the priority only of government telegrams.

3. *Deferred Messages.*—Deferred cablegrams are sent generally at one-half full rates, subject to transmission at the convenience of the company when the cables are free of full-rate traffic. Messages taken at deferred rates must be written in plain language of the country of origin or destination, or in French. The use of more than one language in the same message is not permitted, and code words are excluded, although code addresses may be employed. Figures in their natural sense and general trade terms may be used, but if numbers written in words or figures, or trade terms are employed, the number of such words and groups must not exceed one-third of the number of chargeable words in the text. Ordinal numbers are not included in the above restrictions. With these exceptions, the regular rules for

[1] Hearings on S.4301, 66th Cong., 3d Sess., pp. 277–278.

counting and charging for cable messages apply to deferred messages.

4. *Night Letters.*—Night-letter service is predicated upon the use of cable facilities at times when otherwise they would not be employed, and is designed primarily for a class of plain-language business and social communications which should not be subjected to the overseas-mail delay, but are not of sufficient urgency and importance to warrant payment of full cable tolls on the same. Night letters must be written in plain language of the country of origin or destination, and can be used only where companies or administrations permit their use. Code language is not admissible, and the use of more than one language in the same message is not permitted. The one-third figure rule, stated above in the case of deferred messages, applies also to night letters. Code addresses may be used, except in certain cases, and actually registered cable addresses may be used as signatures. Night letters are subject to transmission at the company's convenience and have a fixed time of delivery, differing with the destinations, but usually within 24 hours. Night letters are accepted for mailing beyond the foreign cable stations. Regular rules for counting and charging, with the exceptions noted, apply.

5. *Special Services.*—American cable companies, like the land lines, offer many special services. A sender, to avoid error, may have a message repeated back upon payment of one-half the full rate in addition to the ordinary tolls. He may also request an acknowledgment of receipt of the message; the charge for acknowledgment of a message of any classification is equal to that for a message of five words, at full rates, to the same destination by the same route. This service is usually of value only where the customer requires prompt proof of delivery of his message, so that the time element is the important factor. The sender of the message receives notice within a few hours of the time of delivery, and is thus able to gauge accurately the conditions existing at the time of delivery. This service also results in better transmission for the original message, since each party handling it must report time of delivery. Business firms cabling to points which their experience has shown to possess inadequate communication facilities find that telegraphic acknowledgment of receipt is advisable on all messages of special

importance. American cable companies also furnish a money-order service to many foreign countries.

Rates.—Rates for international telegraph communication often include, in addition to the terminal charges in the countries of origin and destination, and the charges for transmission, the transit charges of intermediate administrations in cases where the territories, installations, or communication channels of those administrations are used for the transmission of correspondence. Rates are established by word pure and simple, except that for telegrams in code language a minimum charge equal to that for five words for each message, address, and signature counted is collected. The rates for correspondence between the offices of any two countries of the International Telecommunications Union must be equal over the same route and in both directions.

The United States is divided into five zones each for transatlantic, transpacific, and inter-American cable communication. These zones are based roughly upon distance, and generally conform to state boundaries. All points in the same zone bear the same rates, although many cities are singled out for special rates. To illustrate, New York City is in zone 1 for transatlantic communication, zone 1 for communication with the West Indies, Central and South America, and zone 5 for transpacific communication. Corresponding zones for Yonkers, New York, are 1, 2, and 5; and for all other points in New York State, 2, 2, and 5. Rates increase with distance. For classes of service other than the full-rate service, rates are based upon the full rates.

Because of the high cost of cable communication, everything the sender writes upon his blank is counted and charged for, including the text, address, and signature. The address must contain all particulars necessary to ensure delivery of the telegram to the addressee, without inquiries or requests for information. To avoid long addresses the practice has developed among large users of cable service of adopting cable addresses. Such addresses are registered in New York at a central bureau for registered addresses. Under this system a cable address registered with any cable or radio company is referred to the central bureau and is there made available to all companies. An annual fee is charged to restrain unreasonable use of the

registered-address privilege and to prevent the gradual accumulation of obsolete addresses. Messages destined for places beyond the lines of telegraph must contain the name of the place from which they are to be posted or otherwise delivered. The requisite instructions in such cases must be inserted as a part of the address and must be paid for.

Under present rules, the text of international telegrams may be written in clear language or secret language, the latter being divided into code language and cipher language. Clear language is defined by the international regulations to mean

> . . . that which offers an intelligible meaning in one or more of the languages authorized for international telegraph correspondence,[1] each word and each expression having the meaning which is normally attached to them in the language to which they belong;

and code language,

> . . . that which consists either of artificial words, or of real words not having the meaning which is normally given in the language to which they belong and which, for this reason, do not form intelligible sentences in one or more of the languages authorized for clear-language telegraph correspondence, or again of a mixture of real words, as defined, and artificial words.

Cipher language is that which consists of groups or series of arabic figures having a secret meaning, or of words, names, expressions, or combinations of letters not conforming to the conditions of clear language or of code language. Cipher telegrams are charged for at the rate of 5 characters per word, the charge per word being the full rate. Code telegrams also are charged for at the rate of 5 characters per word, but the charge per word is 60 per cent of the full rate in the extra-European regime.[2] Clear-language words are limited to 15 characters. Secret language may not be used in the deferred or letter services.

Each of the languages permitted in international telegrams may be used separately or in conjunction with others in the

[1] Clear-language messages may be written in any language, including Esperanto, that can be expressed in roman letters.

[2] The extra-European regime includes all parts of the world except all the European states, the Azores, Algeria, Bokhara, the Canary Islands, Gibraltar, Malta, Morocco, Asiatic Russia and the Caucasus, Senegal, Mauretania, Tripoli, Transcaspia, Tunis, and Asiatic Turkey.

same telegram, except in the deferred and letter services. In the text of a mixed telegram composed of words in clear language and words in code language, clear-language words are counted on the basis of one word per 5 characters. Such telegrams are charged for at the code rate. If the mixed telegram contains only clear-language and cipher-language passages, it is charged for at the full rate, the clear-language passages being counted at 15 characters per word, and the cipher-language passages at 5 letters or figures per word. Figures are admitted in code messages but are limited to one-half of the total chargeable words and groups contained in the text and signature. They are counted on the basis of one word for each 5 figures. Commercial marks composed of letters and figures also are accepted in code telegrams on the basis of 5 characters per word but they also must not exceed one-half of the number of chargeable words. Messages which contain words in secret language exceeding 5 letters in length and those that contain more than the specified proportion of figure groups or commercial marks are charged for at full rates, each secret-language word being counted on the basis of 5 characters to the word.

The principal problem in cable rate making has centered around the word count for the body of the message. This problem was created by the widespread abuse of code language, due to the development of artificial or spurious words to convey a secret meaning as well as to reduce the number of words necessary to carry on communication, the use of such words growing out of the inadequacies of dictionary words for code purposes. Early attempts by the International Telegraph Union to regulate the use of code language took the form of limiting the number of languages from which code words might be taken, and limiting the length of code words to 10 characters, but the development and use of artificial words rendered these requirements meaningless. Later, it was required that code words be pronounceable, but enforcement of the rule of pronounceability proved to be impracticable. At one conference it was recommended that an official vocabulary be prepared from which all code words should be drawn, and such a vocabulary was prepared at great expense, but it was never adopted. Competition between cable companies was so keen that almost any combination of letters having the semblance of a word came

to be accepted as a code word. As a result of the requirement of pronounceability the practice developed of using 5-letter codes, with the result that two code words could be sent for the price of one. Abuses of code language became so numerous, and added so much to the difficulties and cost of cable communication without bringing compensating revenues, that at the Paris conference, in 1925, a committee was appointed to make a thorough study of code language and to make recommendations. Subsequently, at the Brussels conference, in 1928, the International Telegraph Union permitted the use of two categories of code words. In one, restrictions were placed upon the construction of code words so as to make them conform more nearly to ordinary words but the words might be 10 characters in length; in the other, words were limited to 5 characters but no limitation was placed upon their construction. At the Madrid conference, in 1932, all code words were limited to 5 characters with no restriction upon their construction. The rates for code words, which formerly were the same as the full rates, were fixed at 60 per cent of the full rates in the extra-European regime, with a minimum charge of 5 words for each message, address and signature counted.

An interesting controversy has been raised with respect to the relative charges for code-language and clear-language messages. Code words until recently were charged the same as clear-language words and now are charged only 60 per cent the full rate. Thus there is the anomalous situation of the words which convey the greatest quantities of information bearing the lower rates and the question is raised as to whether the code user should not be required to pay more for code language because this type of language allows him to transmit a greater quantity of information than by clear language. Objections to charging for code-language messages on the basis of the quantity of information are based mainly on two grounds: (1) it would be impracticable to determine the relative amounts of information conveyed in different telegrams, whether in code or in clear language; and (2) any attempt to increase the charges for code telegrams would affect unfavorably the volume of traffic. Code words have been used always not only for purposes of secrecy, but also of economy, especially in international communications over long distances where charges per word of necessity must

be high. The very economy of code language has stimulated the growth of cable communication. Increasing the charges for code messages because of the greater quantity of information they contain would not necessarily increase total revenues. On the contrary, revenues might even decline because communications which could not afford higher rates might seek other agencies of communication. In so far as differences in the cost of handling code messages in contrast with clear-language messages appear, these differences should be compensated for in the rates but if a company has been compensated for extra costs in handling code messages it has no interest in the quantity of information conveyed.

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CHAPTER XIV

RADIO COMMUNICATION

Growth and Development.—Radio, as a communication agency for the general public, has shown a rapid and extensive development, although as compared with wire communications it still is of much less importance. The possibilities of radio communication were demonstrated by Marconi in the closing years of the last century but no regular commercial services had been established in 1902, when the Bureau of the Census made its first quinquennial census of electrical industries. The principal use made of radio in its early years was in the field of marine communication—ship to ship, and ship to shore. By 1912, its importance in this field, as an aid to navigation and in the saving of lives at sea, was given world-wide recognition in a convention requiring the installation of radio apparatus upon all passenger vessels of a certain rating. The United States Congress had already enacted a law, in 1910, requiring that all passenger ships leaving United States ports, whether of American or foreign registry, carrying 50 or more persons, including passengers and crew, and plying between ports 200 miles or more apart, should be equipped with radio apparatus capable of transmitting and receiving messages over distances of at least 100 miles. This act was amended, in 1912, to include all vessels navigating the ocean or Great Lakes, carrying 50 or more persons, including passengers or crew or both. Thus, the development of radio marine communication early was given considerable impetus by legal requirement of the installation of radio apparatus on ships.

Transoceanic radio communication was first successfully demonstrated in 1901, but it was not until the latter part of 1907 that a limited transatlantic commercial service was available. It was not a very dependable service, being subject to the vagaries of atmosphere conditions, but by the end of February, 1908, 119,945 words had been transmitted across the Atlantic.

As was to be expected, commercial radio at first was not a profitable venture. Of six American companies reporting to the Bureau of the Census in 1907, only three reported net income, the others reporting deficits, with a net deficit for the six companies. By 1912, however, the situation had changed. Four companies reported, in the aggregate, total expenses less than income. The number of messages had increased from 154,617 to 285,091, and total income from $106,791 to $669,158. In 1917, the radio stations were taken over by the Federal government, so that the census figures for that year are not comparable with those for the preceding census years. However, estimates for 1917 show an increase of 50 per cent in the number of commercial radio messages over 1912.

The principal American companies engaged in commercial radio communication before the World War were the Atlantic Communications Company, the Federal Telegraph Company, the Marconi Wireless Telegraph Company of America, and the Tropical Radio Telegraph Company. The Atlantic Communications Company, which was German-controlled, operated a station at Sayville, Long Island, in the transoceanic service. The Federal Telegraph Company was originated in 1911 for the purpose, among others, of operating a wireless-telegraph system in the marine service on the Pacific; and the Tropical Radio Telegraph Company was organized principally to conduct the radio operations of the United Fruit Company, of which it is a subsidiary. The principal company was the American Marconi, organized in 1899, partly owned by Marconi's Wireless Telegraph Company, the so-called British Marconi. Until 1912, the American Marconi company did not operate any high-power stations for the transmission of commercial transoceanic messages in regular service, its principal business being the supplying of news service to ships at sea. For this purpose it built land stations on the Atlantic, Gulf, and Pacific coasts. It also rented radio apparatus to the ships using its service. By Dec. 31, 1915, it owned and operated apparatus on over 400 ships, in addition to about 60 land stations, the bulk of such stations in the United States.

Before the war, particularly in the transoceanic field, radio was hampered by its lack of dependability and the crudeness of the apparatus. European companies and the American companies

developed many plans for transoceanic communication but they were ahead of the technical development. The spark transmitters then in use were unable to span vast distances with the degree of certainty necessary for continuous service and for high-speed operation in competition with the cable.

Probably the most significant development in commercial radio during the war was the high-frequency alternator developed by Dr. E. F. W. Alexanderson, an engineer in the employ of the General Electric Company. The machine was demonstrated in 1915, and its worth was immediately appreciated, especially by British radio interests who negotiated for the purchase of a number of alternators. Due to war conditions, however, the negotiations came to naught. The first alternator (50 kw.) was installed at the New Brunswick, New Jersey, station of the American Marconi company in 1917, and the following year the General Electric Company installed a 200-kw. alternator at the same station. This alternator carried the bulk of radio traffic between the United States and Europe from June, 1918, to March 1, 1920, when it was returned to private ownership.

The success of the Alexanderson alternator stimulated interest in transoceanic radio communication, and early in 1919, the British Marconi company began negotiations with the General Electric Company for exclusive rights to the use of these instruments. Had these negotiations been consummated British interests would have largely dominated transatlantic radio communication because of their interest in the American Marconi company. The General Electric Company did not come to terms with the British Marconi company but took steps looking forward to the formation of a new radio company. It purchased the block of stock of the American Marconi owned by the British Marconi and, in the latter part of 1919, the Radio Corporation of America was organized, which took over the assets of the American Marconi company. At the same time a contract was entered into by the General Electric Company and the Radio Corporation of America whereby the latter company secured rights under the patents owned and controlled by the General Electric Company; the Radio Corporation of America agreed to purchase exclusively from the General Electric Company all radio apparatus and devices required by it, and the General Electric Co. agreed to manufacture exclu-

sively for the Radio Corporation. Thus, the Radio Corporation obtained control of most of the privately owned high-power stations in the United States, together with a number of important patent rights.

Between 1920 and 1924, transoceanic radio communication was carried on by the use of alternators on circuits with wave lengths of 10,000 to 25,000 meters. These alternators made fairly satisfactory communication possible during the cool six months of the year but during other seasons heavy static hampered traffic and imposed serious limitations upon continuous transmission. In 1924, short-wave transoceanic communication was introduced on a commercial basis, and gradually, with increased knowledge of the characteristics of each wave length, the chief defects of short-wave communication, static and fading, were circumvented and the short waves assumed a position of importance in international communication. Today, most of the world's long-range radio communication is conducted over wave lengths between 14 and 50 meters.

The scope of the communication activities of the Radio Corporation has increased continuously and rapidly since its incorporation. At present it has 57 circuits which connect the United States and its possessions with 47 foreign countries. The international circuits of the Radio Corporation are used also to carry broadcasting programs to and from the United States. During 1934, this company handled 715 international programs for American broadcasting companies. The Radio Corporation also participates in the operation of the transpacific telephone service which links Honolulu and the Philippines with the United States and Canada via San Francisco; and in radiotelephone circuits connecting the Philippines with Java, Siam, and with Europe, via Berlin. It has domestic radiotelegraph circuits between Boston, New York, Philadelphia, Baltimore, Washington, Detroit, Chicago, New Orleans, San Francisco, Los Angeles, and Seattle, which handle domestic messages between these points, as well as messages originating in or destined to them and transmitted over the international circuits. On the domestic circuits, the Radio Corporation is about to introduce multiplex transmission, by which three different messages may be sent simultaneously over the same wave length. Multiplex radio transmission, by which two

automatic printer channels are operated simultaneously on a single radio frequency, was introduced between New York and London, in 1934. Facsimile communication is the method of obtaining at the receiving end an exact reproduction of the message, photograph, or document sent at the transmitting end. The Radio Corporation now has four facsimile circuits in operation, radiating from New York to San Francisco, to London, to Berlin, and to Buenos Aires. In addition, it proposes to introduce high-speed facsimile radio-communication service, the first circuit to be between New York and Philadelphia. The transoceanic and domestic communications services of the Radio Corporation are carried on by its subsidiary, R. C. A. Communications, Inc.

While the Radio Corporation was developing its transoceanic service, it was also improving and extending marine radiotelegraph service. Soon after its organization in 1919, it inaugurated a marine radiotelegraph business similar to that which had been carried on by the Marconi Wireless Telegraph Company of America. This service has been extended until today from 16 stations located along the east, west, and gulf coasts of the United States, and the shores of the Great Lakes, it maintains radiotelegraph communication with ships plying the oceans and the Great Lakes. The Radio Corporation leases or sells, inspects, and repairs radiotelegraph equipment for use on ships. It also leases and sells radio direction finders, apparatus by which ships at sea can determine their exact positions from radio beacons on the shore and relative to the positions of other ships at sea. Besides messages for ships and passengers, news matter is transmitted to subscribing vessels for the publication of newspapers and news bulletins on shipboard, and broadcast information and entertainment for travelers, all on a commercial basis. In 1934, the Radio Corporation made two new contributions to marine radio communication: the sea-letter telegram, by which a person aboard ship may send a message which is forwarded from the coastal station to the addressee by first-class or special-delivery mail; and the marine gift service, which enables persons ashore to "radio" gifts to friends at sea, or vice versa. This marine service is conducted by its subsidiary, the Radiomarine Corporation of America.

Next in importance of the American radio companies is the Mackay Radio and Telegraph Company, now controlled by the International Telephone and Telegraph Company. This company was organized in 1927 to buy the properties of the Federal Telegraph Company of California, consisting of three coastal radio and ship-to-shore stations at Los Angeles, San Francisco, and Portland on the Pacific Coast. The Federal had had a San Francisco-Honolulu circuit before the war but this circuit was not reestablished until the Federal was taken over by the Mackay company. In 1928, the Mackay company leased the old German station at Sayville, Long Island, from the United States Navy, which had taken it over upon our entry into the World War, and this station entered into international communications early in 1931. At the end of 1934, this company had circuits connecting the United States with Argentina, Austria, Chile, China, Colombia, Cuba, Denmark, Hawaii, Hungary, Japan, Peru, the Philippine Islands, and Vatican City.

In the marine service the Mackay company has more than 260 ships under contract for radio repairs, radio servicing, and supplying radio operators; it maintains stations for servicing ships at all important United States and foreign ports, and it is contracting regularly for the supply of modern radio apparatus and radio compasses to a growing number of vessels. The Federal Telegraph Company, now an affiliated manufacturing company, makes the apparatus supplied to vessels and Kolster radio compasses that are leased or sold by the Mackay company. Through the combined efforts of the manufacturing, communications, and sales divisions and their affiliates, and by relationship with other companies in the International Telephone and Telegraph system, the Mackay company covers the complete range of operations in the commercial radio field.

A third company engaged in commercial transoceanic radio communication is the Tropical Radio Telegraph Company. Its business is mostly concerned with the operation of the ships of the United Fruit Company, although its stations have been opened to commercial use, and it is the principal company operating in the Gulf of Mexico and the Caribbean Sea. By an agreement, concluded in 1921, under which the Tropical company was permitted to use radio apparatus controlled under patents by the Radio Corporation, messages of the former

company destined to points in the United States, as well as those from the United States to points reached by the Tropical, must be transmitted through the facilities of the Radio Corporation.

Other companies engaged in commercial transoceanic radiotelegraph communication are Globe Wireless, Ltd., subsidiary of the Robert Dollar Steamship Company; and U. S. Liberia Radio Corporation, a subsidiary of the Firestone Tire and Rubber Company. These companies perform only a limited public service. Their radio services were installed in the beginning to facilitate the conduct of business operations by the parent corporations, but in order to retain the frequencies they use, they have been compelled to open their stations to the public service. In addition, Press Wireless, Inc., is engaged in the transmission of press traffic between stations in the United States, South America, Mexico, Canada, Hawaii, and Denmark.

The total number of commercial radio messages reported to the Bureau of the Census grew from about 420,000 in 1917 to 2,365,009 in 1922, and to 3,777,538 in 1927. Revenue from transmission was $4,207,785 in 1922, and $6,226,188 in 1927, and other operating revenues $3,644,201 in 1922 and $14,791,565 in 1927. Total revenues exceeded total expenses by about $3,000,000 in 1922, and about $12,000,000 in 1927.

Transoceanic and marine radio communication continued to grow after 1927, although during the past few years they have experienced the effects of business depression. In 1929, the radio handled a considerably increased proportion of the transatlantic communications business, due to the fact that an earthquake interrupted about one-half of the cables in the North Atlantic in November of that year. In 1930, and again in 1931, the volume of transoceanic commercial radio communications declined, although radio carried about its usual proportion of the total. In 1932, the volume declined still further owing to the fact that the foreign trade of the United States, which in past years has contributed the bulk of American international communications, reached the lowest dollar value in three decades. Since 1932, radio revenues, like cable revenues, have risen considerably.

Domestic telegraph communication by radio has reached only a slight degree of development. At the end of 1934, the Mackay

Radio and Telegraph Company had radiotelegraph stations at Seattle, Tacoma, Portland, San Francisco, Oakland, San Diego, and Los Angeles on the Pacific Coast, and in Chicago, New Orleans, Washington, Boston, and New York. It renders a domestic radiotelegraph service between these cities and, by transfer, to all points reached by the Postal Telegraph system. The domestic service of the Radio Corporation has already been mentioned. In addition to these, the Western Radio Telegraph Company operates a service in an oil-producing region in Texas, Oklahoma, and New Mexico where wire facilities are inadequate, and where because of shifting populations and producing areas the installation of permanent wire systems would not be warranted; and the American Radio News Corporation is engaged in the transmission of press traffic, with stations located in New York, Chicago, Denver, San Francisco, Atlanta, and in Mexico City, Mexico.

Radio Broadcasting.—Radio broadcasting is almost altogether a post-war development, although successful demonstrations had been made before the war. Beginning in 1920 as a novelty, broadcasting soon attracted much attention, and it was not long before it was put to commercial use. Receiving sets were sold in great numbers, and sponsorship of programs came from those who saw the possibilities of broadcasting as an advertising medium. Today there are more than 22,000,000 receiving sets in the United States and about 630 broadcasting stations. A study of the financial condition of broadcasting stations, in 1931, by the Federal Radio Commission showed that 573 stations possessed total physical assets amounting to \$30,578,680, of which \$20,196,137 represented investment in technical equipment such as generators, transmitters, antennae, etc. Gross receipts reported for individual stations, in 1931, aggregated \$38,461,302; and gross advertising revenue reported for chain companies aggregated \$39,296,746, making a total of \$77,758,049.[1]

Radio broadcasting is a unique service. In some respects, such as in the broadcasting of news and market reports, talks, and advertising matter, it resembles other communication agencies, but it is mostly an entertainment and educational

[1] Commercial Radio Advertising, Senate Doc. 137, 72d Cong., 1st Sess., pp. 43–44.

service. Broadcasting is legally not a public utility, although it has certain of the characteristics common to most public utilities. A license must be obtained from the Federal government before a broadcasting station may be constructed and operated, and broadcasting is a natural monopoly in that the number of stations which may operate simultaneously is absolutely limited by natural laws and each station has a monopoly of its frequency in the territory it serves. Furthermore, by its very nature broadcasting is a public service. The signal which is broadcast may be received by all within the territory covered who have proper receiving apparatus, and conversely, all those desiring service within a given territory are dependent upon the stations which serve that territory. On the other hand, it differs materially from the industries which are classed as public utilities.

In all public utility industries the consumers of the services pay directly the costs of supplying them, and in many foreign countries a similar system has been adopted for the support of broadcasting, the listeners being charged fees for the operation of receiving sets. In the United States, however, the revenues of broadcasting stations are not obtained directly from the listeners, but from advertisers who are willing to sponsor programs in return for the inclusion of advertising messages in them. Thus, there is no problem of rates to the ultimate consumers. However, charges are made to advertisers by broadcasting stations and the problem of discrimination between advertisers may become, if it has not already, a matter of public concern. In the only case involving broadcasting rates which has come before a Federal regulatory body, the Interstate Commerce Commission, which formerly had jurisdiction over the rates for interstate communication, held that radio broadcasting was not included among the specified communication utilities to which the provisions of the Interstate Commerce Act applied.[1] The Communications Act of 1934 specifically declares broadcasting not to be a common-carrier service. Thus, the provisions of that law regarding common carriers are not applicable to broadcasting.

The principal aspect of the radio-broadcasting service which distinguishes it from public utility services generally is the

[1] *Sta-Shine Products Co. v. Station WGBB*, 188 I.C.C. 271.

utter lack of standardization of the product or service sold. A kilowatt of electrical energy is the same wherever it is supplied; so is a cubic foot of gas of given B.t.u. content or quality. But a broadcasting station merely sells "broadcast time," and the unit of time is inseparably connected with the program to be broadcast. Some hours of the day are better than others for certain advertisers, as are certain days of the week, or seasons of the year, and the programs to be broadcast are least of all susceptible of standardization. So long as broadcast programs are to be designed to suit the varied likes of the listening public, standardization must be avoided, and opportunity provided for initiative, ingenuity, and showmanship. Regulation must confine itself to the avoidance of interference and the prevention or elimination of abuses. Radio-broadcasting stations cannot be made available to any or all persons who desire to broadcast, for the interests of the listeners must be paramount. On the other hand, only those who can best serve the public should be permitted to use the limited facilities available for broadcasting. The Federal Radio Commission well distinguished broadcasting from other public utility services, as follows:

The service to be rendered by a station may be viewed from two angles, (1) as an instrument for the communication of intelligence of various kinds to the general public by persons wishing to transmit such intelligence, or (2) as an instrument for the purveying of intangible commodities consisting of entertainment, instruction, education, and information to a listening public. As an instrument for the communication of intelligence, a broadcasting station has frequently been compared to other forms of communication, such as wire telegraphy or telephony, or point-to-point wireless telephony or telegraphy, with the obvious distinction that the messages from a broadcasting station are addressed to and received by the general public, whereas toll messages in point-to-point service are addressed to single persons and attended by safeguards to preserve their confidential nature. If the analogy were pursued with the usual incidents, a broadcasting station would have to accept and transmit for all persons on an equal basis without discrimination in charge, and according to rates fixed by a governmental body; this obligation would extend to anything and everything any member of the public might desire to communicate to the listening public, whether it consist of music, propaganda, reading, advertising, or what not. The public would be deprived of the advantage of the self-imposed censorship exercised by the program directors of broadcasting stations who, for the

sake of the popularity and standing of their stations, will select entertainment and educational features according to the needs and desires of their invisible audiences. In the present state of the art there is no way of increasing the number of stations without great injury to the listening public, and yet thousands of stations might be necessary to accommodate all the individuals who insist on airing their views through the microphone. If there are many such persons, as there undoubtedly are, the results would be, first, to crowd most or all of the better programs off the air, and second, to create an almost insoluble problem, *i.e.*, how to choose from among an excess of applicants who shall be given time to address the public and who shall exercise the power to make such a choice.

To pursue the analogy of telephone and telegraph public utilities is, therefore, to emphasize the right of the *sender* of messages to the detriment of the listening public. The Commission believes that such an analogy is a mistaken one when applied to broadcasting stations; the emphasis should be on the *receiving* of service and the standard of public interest, convenience, or necessity should be construed accordingly. This point of view does not take broadcasting stations out of the category of public utilities or relieve them of corresponding obligations; it simply assimilates them to a different group of public utilities, *i.e.*, those engaged in purveying commodities to the general public, such, for example, as heat, water, light, and power companies, whose duties are to *consumers*, just as the duties of broadcasting stations are to listeners. The commodity may be intangible but so is electric light; the broadcast program has become a vital part of daily life. Just as heat, water, light, and power companies use franchises obtained from city or state to bring their commodities through pipes, conduits, or wires over public highways to the home, so a broadcasting station uses a franchise from the Federal government to bring its commodity over a channel through the ether to the home. The government does not try to tell a public utility such as an electric light company that it must obtain its materials, such as coal or wire, from all comers on equal terms; it is not interested so long as the service rendered in the form of light is good. Similarly, the Commission believes that the government is interested mainly in seeing to it that the program service of broadcasting stations is good, *i.e.*, in accordance with the standard of public interest, convenience, or necessity.[1]

Special Radio-communication Services.—In addition to the general communication services and broadcasting, radio has

[1] In the matter of the Application of Great Lakes Broadcasting Co., Third Annual Report, Federal Radio Commission, 1929, p. 32.

been adapted to suit many special communication needs. Radio communication has become an indispensable adjunct to the successful operation of extensive air-transport systems. It is used for communication between aircraft and land stations and for communication between land stations in connection with the handling of messages relating to the safety of life and property in the air or in connection with the relay of messages destined for or originating on aircraft and relating solely to the actual aviation needs of the licensees. All aeronautical ground stations must provide service without discrimination to all transport aircraft, the owners of which desire the service and cooperate in its operation, maintenance, and liability, and reasonable and fair service to itinerant aircraft. Formerly, all stations operating in the aviation service were forbidden to carry on public correspondence for tolls but more recently regulations have been relaxed so as to permit the handling of general-public-message correspondence between aircraft and aeronautical ground stations in order to enable passengers in aircraft to send and receive private radiotelegrams. However, the new rules provide that in the handling of messages for the public, priority must be given to safety messages. To this end, the equipment to be used and the operators' listening watches must be such as to permit the immediate interruption of public service messages whenever it is necessary to send or receive emergency traffic.

Radio is also used in the police service for communication between central stations and police cars or other mobile units; in the geophysical service for the determination of the physical characteristics of the strata below the surface of the earth; by power and light companies when all other forms of communication fail; in the motion-picture industry for communication between field-production units, or between headquarters and field-production units; and for many experimental purposes. The number and classes of radio stations in the United States, as of June 30, 1935, are shown in Table 39.

Government Communication Systems.—The United States goverment owns and operates a number of communication systems. These, however, handle only government traffic, or in some cases communications for employees of the government, or for the general public, where commercial facilities are not available. They include the following:

1. Under the Commerce Department, a radiotelegraph system for the airways division and marine beacons for the Lighthouse Service.

2. Under the Treasury Department, a system of radiotelegraph stations on both coasts of the United States for the Coast Guard for communication with their ships and for purposes of safety of life at sea.

3. Under the Department of the Interior, a radiotelegraph service for the Forestry section.

4. Under the Navy Department, a radiotelegraph system of communication between both coasts, between the naval districts, on both coasts to ships at sea (including radio direction-finder stations), and to Hawaii, Alaska, Manila, Panama, Puerto Rico, Guam, and Samoa.

5. Under the War Department, cable and radio service to Alaska, a radio and wire telegraph network within the United States and Alaska, and a radiotelegraph service to its overseas units and transports.

Economic Characteristics.—Radiotelegraphy is a record communication service and the problems of collection and delivery of messages are like those of wire telegraphy. The principal differences between the two services are the medium by which transmission is effected and the terminal apparatus. Radio has extended the field of electrical communication by introducing new services and has won for itself a strong position in competition with wires for traffic which until the coming of radio they had thought securely theirs. The radio has supplemented other agencies by providing instantaneous communication with points to which the construction of wire lines, or the laying of cables, would not be physically or economically feasible and has provided alternative or additional facilities for occasions when wire facilities are interrupted or overloaded. It has provided the only known means of communication with moving objects, except over short distances.

In competition with the cables, the radio has the advantages of cheapness, flexibility, and direct communication. A further advantage from the viewpoint of national security is that radio is less likely to be interrupted in wartime or disaster, since it cannot be cut, diverted, or destroyed by enemy or catastrophe. As to relative costs of operation, no figures are available for

TABLE 39.—NUMBER OF RADIO STATIONS IN THE UNITED STATES
(June 30, 1935)

Nature of Service and Class of Station	Number of Stations
Agriculture: point-to-point telegraph	9
Amateur	45,561
Aviation:	
Aeronautical	193
Aeronautical point-to-point	96
Airport	27
Aircraft	359
Marker beacon	3
Broadcast	623
Emergency:	
Police, municipal	194
Police, state	58
Marine fire	2
Special emergency	44
Experimental:	
General experimental	849
Special experimental	126
Experimental relay broadcasting	12
Experimental visual broadcasting	21
Experimental broadcast	4
Fixed public:	
Point-to-point telegraph	377
Point-to-point telephone	111
Fixed public press: point-to-point telegraph	77
Geophysical	131
Marine relay	42
Mobile press	5
Public coastal:	
Coastal telegraph	110
Coastal telephone	2
Coastal harbor	37
Private coastal:	
Coastal telegraph	3
Coastal harbor	2
Ships	1,961
Temporary:	
Broadcast pickup	34
Motion picture	1
Total	51,074

Source: First Annual Report of the Federal Communications Commission, 1935, pp. 5–6.

exact comparisons. However, it has been demonstrated that the total costs of short-wave communication over long distances are less than those for equivalent cable facilities between the same points, the principal difference being due to lower investment costs for radio. Radio is cheaper also in the matter of repairs and renewals but these advantages are in part offset by the more rapid depreciation and obsolescence of radio equipment.

Radio is more flexible than the cable in that a radio station may shift from one circuit to another as convenience or necessity dictates, whereas, a cable once laid is usable only between the points connected. This is an important consideration where shifts occur in the direction of the flow of international communications and where the volume of communications over a given route varies materially and rapidly with changing circumstances. The advantage of direct communication with a foreign country which radio offers is also significant. It enables the direct transmission of a message from one country to another and thus avoids transmission through an office in an intermediate country. This makes the service speedier and allays suspicion and ill feeling between nations engendered by actual or assumed leakage of valuable trade or other information to third parties.

Radio labors under certain disadvantages, however, although some of the claimed disadvantages, like lack of secrecy and unreliability, are more apparent than real at the present time. The speed at which many radio circuits are operated, and the fact that many messages are in code, preclude reception of messages by the general public. Also, the use of different frequencies during different hours of the day or seasons of the year, and improvement in terminal apparatus, especially the diversity method of reception, by which three antennae spaced about 1,000 feet apart are connected with a central receiver, have done much to improve the reliability of radio communication. The real handicap of radio in the international field, so far as the Radio Corporation is concerned, is the lack of domestic pickup and delivery services of its own.

In the international service, radio, like the cable, has a relatively poor load factor. The two services are largely competitive and the hourly distribution of traffic is similar for both, the peak of the transatlantic traffic coming during those hours in which the business days in Europe and the United States overlap. This

requires the provision of facilities and personnel ample to meet the peak which are partly unused at other times, although many circuits must be manned during the entire 24 hours regardless of the volume of traffic. The volume of communications varies somewhat with seasons, corresponding roughly with curves of

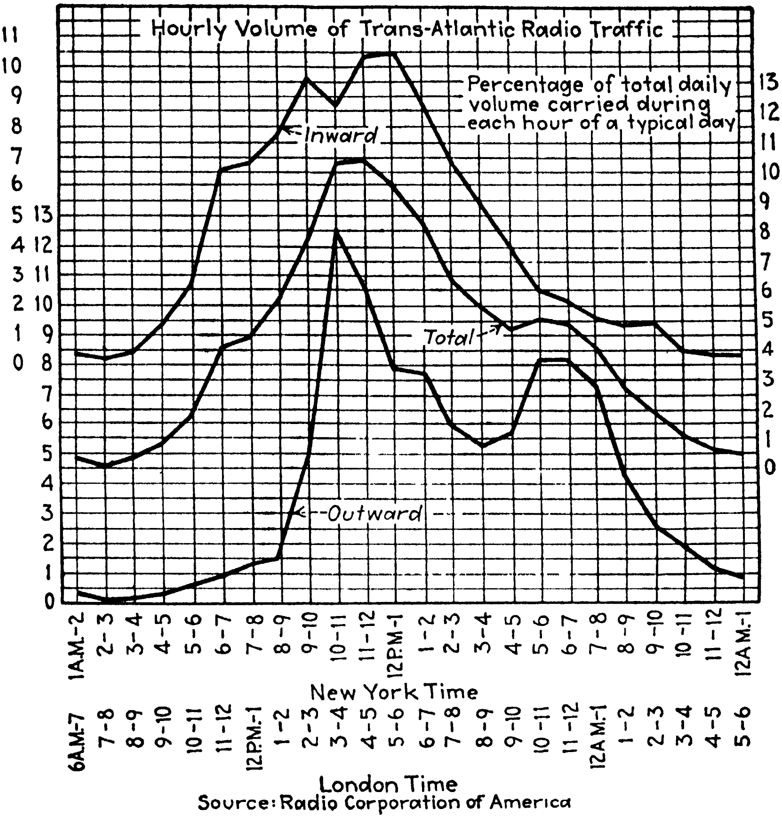

FIG. 13.

import and export operations in the United States. Unusual activity in the stock market is reflected by an increase in the volume of communications. The heaviest volume of traffic usually comes during the months from October to March, inclusive, and the lowest during the months from June to August, inclusive. Traffic is unusually heavy in the 10 days preceding Christmas and a day or two before New Year's Day, due to the volume of holiday greetings. The hourly distribution of

transatlantic traffic of R.C.A. Communications, Inc., for a typical business day is shown in Fig. 13.

Classes of Service and Rates.—Classes of service in transoceanic radiotelegraph communication, due to the competitive situation, necessarily are similar to those established by the cable companies. They consist of full-rate, deferred, and urgent radiograms, and radio letters. Also, supplementary radiotelegraph services similar to cable are offered, such as prepaid replies, repeated messages, notice of delivery, etc. Rules governing word count and charging for transoceanic radio messages, as well as the charges, are the same as those for cable traffic. Rules governing the word count and the charges for domestic radiotelegraph messages are practically the same as those of the wire companies for messages between the same points, except that the minimum number of words is 15, instead of 10 as allowed by the wire companies, and for letters 60, instead of 50 words.

Radio messages to and from ships at sea are handled by the telegraph and radio companies in a coordinated service. The cable system of counting and charging is used throughout in marine messages, the address, text, and signature being charged for. Registered code addresses may be employed in messages which originate at ship stations for delivery on shore. Provision is also made for prepaid replies, repetitions, notice of delivery, etc., in this service. The through rates of the Western Union and the Radiomarine Corporation are made up by adding the land-telegraph rates to the radio rates. Land-telegraph rates for the marine service are state rates, varying with distance from the radio station, all points in the originating or terminating state having the same rates. The radio rates are quoted from the North Atlantic Coast, Atlantic and Gulf Coast, and Pacific Coast stations of the Radiomarine Corporation, with different schedules for transoceanic, for American-owned coastwise, and for foreign-owned coastwise vessels. Rates to and from the St. Lawrence and Great Lakes stations are the same for all vessels.

Regulation of Radio Communication. *The International Telecommunication Convention.*—Radio communication by American companies is subject, in the first place, to international regulation, the necessity for such regulation being due primarily to natural limitations upon radio communication. Certain fre-

quencies may be used simultaneously without objectionable interference by two or more stations if they are separated by sufficient geographical distances. Others, however, because of their interference range, may be used satisfactorily only by one station at any given time. So long as there were only a few stations operating, frequencies were plentiful and objectionable interference could be avoided, but the rapid development of radio communication which followed the World War, together with the wide variety of uses to which radio was adapted, brought so many stations into existence that international cooperation in the utilization of available frequencies became imperative. The need for international regulation was pressing in the early years following the war, but the successful utilization of the short waves made available an unexpected, and at first thought to be an inexhaustible, supply of frequencies, and the urgency was relieved. By 1927, however, conditions were so unsatisfactory that representatives of the various nations met in Washington and drew up a covenant and general regulations to govern radio communications.

The Washington conference was not the first international body to regulate radio. As early as 1903, a conference was held in Berlin which, although it dealt with few problems, led to a later conference, in 1906, at which many rules and regulations governing communication practices were adopted. In 1912, at a conference in London, important rules governing the marine service were drawn up and, in 1914, a Safety of Life at Sea Convention was adopted. No further conferences were held until 1927.

The Washington conference drew up an agreement to govern the broader aspects of international radio communication which consisted of three parts: (1) an International Radiotelegraph Convention, (2) general regulations annexed to the International Radiotelegraph Convention, and (3) supplementary regulations annexed to the International Radiotelegraph Convention. The Convention included matters which concerned chiefly the sovereign governments as governments; such as provisions governing intercommunication, the secrecy of correspondence, connection with the general communication systems of the countries involved, the exchange of information regarding stations and service, conditions to be observed by stations,

priority of distress calls, suspension of service, the establishment of an international technical committee, and many provisions governing arbitration, adherence to, execution, ratification, duration, and renunciation of the Convention. The general regulations covered matters of a more detailed nature necessary to the satisfactory conduct of international radio communication, its improvement and development; and the supplementary regulations, certain details of operation and charges. The United States became signatory to the Convention and the general regulations, but not to the supplementary regulations.

At Madrid, in 1932, the principal nations of the world held a joint conference which was attended by representatives of cable, radio, and telephone interests, at which an agreement was drawn up governing all forms of international telecommunication. This agreement consisted of an International Telecommunication Convention and several sets of detailed regulations annexed thereto, including telegraph, telephone, and radio regulations, the radio regulations being divided into general and additional regulations. The Convention provided that any nation in order to become signatory must also adhere to at least one of the sets of annexed regulations. The United States is signatory only to the Convention and the general radio regulations. The Madrid Convention and the general radio regulations made few significant departures from those adopted at Washington in 1927.

In its relations with other nations where communication matters are involved, the government of the United States has adopted the definite policy of not subscribing to international agreements which would tie the hands of the private communication companies in the United States in matters which should be under their control. For this reason it never was signatory to the International Telegraph Convention, and its adherence to international radio agreements has been only to the extent necessary for international cooperation. The peculiar situation of the United States with regard to such matters, especially in dealing with governments which own or control communication facilities, has been explained as follows:

The government of the United States has, outside of its military establishments, no facilities for the transmission of messages for the public either by telegraph, cable, telephone, or radio. In keeping with

its institutions generally, it has always stood committed to the principle of private ownership and operation, subject to such governmental regulations as may be necessary to prevent abuse and ensure fair service. The communication systems and other large public service agencies of the United States were established and have grown up under this policy. They are private property, the ownership and management of which are limited only by those considerations which, under American law, are applicable to such property when dedicated to public use. Such private ownership and right of management are complete, subject to such regulation as is necessary in the public interest.[1]

The main problem with which international radio conferences have been concerned is that of interference. International cooperation is absolutely essential if efficiency is to be maintained, since in most cases two or more stations may not operate on the same frequency unless they bind themselves to observe certain prearranged conditions, and where only one station the world over may operate on a given frequency at a given time, agreement must be reached as to use of such frequencies. The signatory nations have agreed that any nation may assign any frequency to any radio station under its jurisdication on the sole condition that its operation shall not interfere with that of any established station of any other country. They have agreed further to make assignments to different classes of stations in accordance with a general plan of allocation in the case of frequencies the use of which might cause material international interference. This frequency allocation is not an allocation to countries; it is entirely an allocation to services, all countries having equal rights to the use of all frequencies, subject to the above-mentioned limitations.

The radio spectrum (10 to 23,000 kilocycles) is divided into bands of frequencies and allocated to the various services. In the low-frequency band (10 to 100 kilocycles) stations are of the super-power type, no duplication on the same channel being permissible throughout the world. These frequencies are allocated for point-to-point international communication.

Communication on the intermediate frequencies (100 to 550 kilocycles) is carried on with transmitters of less power than on the low frequencies; consequently, duplication of assignments

[1] International Radiotelegraph Conference, Proposals of the United States of America, Government Printing Office, 1927, p. 3.

may be allowed on certain of these frequencies whenever it is certain that the ratio of power to distance is such that no interference will result between stations. For example, ships operating in the Pacific may use the same working frequencies that are assigned to ships operating in the Atlantic. In this band are found a large proportion of the frequencies designated for ship use, including channels for distress signals. All radio-beacon and radio-compass services are likewise located in this band, primarily because of the peculiar characteristics of high frequencies which render them not sufficiently dependable for such services. Certain aeronautical and aviation mobile services also are found in this band, as is European broadcasting. The band of frequencies from 550 to 1,500 kilocycles has been set aside exclusively for broadcasting, except that the frequency 1,365 kilocycles may be used in the maritime mobile service.

The medium high frequencies (1,500 to 6,000 kilocycles, often called the continental band) are not considered to have an intercontinental interference range, hence their use may be duplicated in different parts of the world. On the North American continent, however, agreement concerning their use is necessary. Provision is made for both fixed and mobile services in this band as well as for amateurs. Among the services which have been authorized in this band in the United States are: communication between airplane and ground stations, communication between ships and coastal stations, police communications, marine calling, geophysical service, service for scientific expeditions, portable service, power-company emergency communications, experimental and development work, and amateur service. Allocations also have been made to the press service, and some for general communication service.

The high-frequency band (6,000 to 23,000 kilocycles) has been reserved mostly for international communications. Other services provided for in this band are maritime and aviation mobile service, broadcasting, and amateur services. At the Madrid conference a few allocations were made in the band of frequencies ranging from 23,000 to 60,000 kilocycles.

The North American Agreement.—In order that the frequencies between 1,500 and 6,000 kilocycles may be used most effectively on the American continent, it is necessary that the United States, Canada, Mexico, Cuba, and the other nations agree upon an

allocation of them. Such an agreement was reached between the various nations concerned, for the services other than broadcasting, in January, 1929, which became effective March 1 of that year. At a conference in Mexico City, Mexico, in 1933, further agreement was reached with regard to the disposition of these frequencies. The North American Agreement provides that each country shall be free to assign any frequency to any radio station within its jurisdiction upon the sole condition that no interference with any established service of another country will result therefrom, but that each government shall use the allocation contained in the agreement in assigning channels to the various services specified therein. Channels are divided into two classes: (1) common channels which are primarily assigned to particular services in all countries, and (2) general communication channels which are assigned for use in specific countries. The frequencies are first allocated to the various services, and a second allocation of the general communication frequencies to the different countries is made. Each government has the right to assign to stations under its jurisdiction, in the manner it deems best, such general communication frequencies as are allocated to it under the agreement but not to assign to such stations general communication frequencies allocated to other governments, unless it may be accomplished without interference with established services.

Regulation in the United States.—Under the Radio Act of 1927, the regulation of radio communication in the United States was placed in the hands of the Federal Radio Commission, created by this act. The Radio Act was passed principally because of the need to correct or eliminate a multitude of abuses which threatened to destroy radio broadcasting, but its terms embraced all forms of radio communication. The sections of the act, as amended, which related to radio communication other than broadcasting forbade the establishment or operation of a radio station in the United States without a license. The Commission was given powers, among others, to classify radio stations; to prescribe the nature of the service to be rendered by each class of licensed stations and each station within each class; to assign bands of frequencies to the various classes; and to assign frequencies for each individual station and to determine the power which each station might use and the time during

which it might operate; to determine the location of classes of stations or of individual stations; to regulate the kind of apparatus to be used with respect to its external effects and the purity and sharpness of the emissions from each station and from the apparatus therein; to make such regulations not inconsistent with law as it might deem necessary to prevent interference between stations and to carry out the provisions of the act; to prescribe the qualifications of station operators, to classify them according to the duties to be performed, and to issue licenses to those qualified; to suspend the licenses of operators for cause; and to inspect all transmitting apparatus. Similar powers have been granted to the Federal Communications Commission by the Communications Act of 1934.

For the guidance of the Commission in making determinations as to parties to be licensed or to be refused a license, and in its administration of the provisions of the law, Congress laid down no rules, except to require that all operation should serve the "public interest, convenience, or necessity." Regulation of radio communication, as a practical matter, has consisted of the application and interpretation of this phrase. The Commission repeatedly was asked to define the phrase but it constantly refused to do so on the grounds that precise definition which would foresee all eventualities was impossible, and it has made its interpretations in individual cases on the basis of the facts of record. Nevertheless, the Commission was compelled to formulate certain general principles to serve as guides in the distribution of available frequencies, for from the beginning it was besieged by more applications for facilities than could be supplied and it had to choose between different applicants for the same facilities. Some of these principles, more or less well defined, applicable to radio communication other than broadcasting, may be stated as follows:

1. The allocations must be subject to and in conformity with the terms and conditions laid down in the International Radiotelegraph Convention and in the North American Agreement.

2. Loss of use of any of the channels, arising from the presence of a greater number of stations than can be accommodated and the resulting interference, must be avoided.

3. Because the number of available frequencies is limited, channels of radio communication must be conserved to their

most vital uses, avoiding the granting of channels to applicants whose use thereof would be inappropriate, uneconomic, or wasteful. (*a*) Assignment of frequencies should be made first to those services designed to bring out the inherent advantages of radio communication. (*b*) Assignment of frequencies should not be made to applicants for special services which would substantially duplicate those of other established communication agencies, but to those who would provide radio facilities where such other means are inadequate. (*c*) In communication between continents or between continents and insular bodies, the use of radio should be confined to a relatively small number of points and reliance placed upon existing systems for the distribution and collection of messages. (*d*) Assignments of the limited number of frequencies should ordinarily not be made where only a limited number of persons would be served.

4. Competitive service should be established where there are competing applications, or an application or applications to compete with already established service, and in the grant of competing licenses, fairness of competition should be established, except that as to an isolated country, which, in the judgment of the commission, will not afford sufficient business for competing wireless lines, only one grant of license should be made, preferably the first application in priority.

5. Proposals should be technically feasible, and the applicants should be able to demonstrate financial ability to carry out their proposals.

6. In general, facilities should be granted only to public service, and not to private organizations. Where for special reasons radio facilities are granted to organizations primarily engaged in private business such licensees should be placed under an obligation to accept messages from the general public and to serve any and every one of the public equally and fairly.

In granting licenses to applicants for radio facilities, other than broadcasting, the Commission followed the general policy of granting them only on a public utility basis. It was besieged continually by applicants whose use would primarily be private, but it held that the use of radio facilities should be primarily in the interests of the general public. Probably a few illustrations will serve to clarify the position taken by the Commission.

The Robert Dollar Steamship Company applied for permits to construct radio stations at New York and San Francisco to provide communications in conjunction with the operation of its "Round-the-World" passenger service and other passenger and cargo services. The facilities were granted by the Commission only on the condition that this company would maintain a public service in which messages would be accepted from and delivered to the general public. The Dollar company accordingly organized Globe Wireless, Ltd., to take over its radio operations and to operate on a public utility basis. The same principle was applied to the operations of the Tropical Radio Telegraph Company and the U. S. Liberia Radio Corporation.

The Commission dealt similarly with certain allocations in the continental band. Newspapers and press associations have from the beginning been interested in radio communication and when the Commission faced the problem of assigning frequencies to applicants for both transoceanic and continental frequencies, it found many applications from the press. It set aside 20 transoceanic and 20 continental frequencies for the exclusive use of the press and favored the establishment of a single public service corporation to conduct radio communications on these frequencies for the entire press on a public service basis. The various newspapers and associations, however, stood out for allocation on an individual basis, but failing to arrive at a distribution of frequencies satisfactory to all, largely through the intercession of the Commission, Press Wireless, Inc., was organized and to it were allotted the frequencies set aside for the press. This corporation is a public utility engaged in the conduct of radio communication on a public utility basis for the American press.

In the matter of assigning radio facilities to aviation companies, the Commission also applied the public service principle. Although increased safety and increased reliability in air transportation were in large measure due to radio, there were not enough frequencies available for aviation use to enable each company to obtain all it could desire. Consequently, the Commission had to adopt a definite plan so as to make possible the most effective use for all concerned. Under the present organization there are seven major chains of radio stations for aviation purposes. The frequencies set aside for aviation are

assigned to companies or agencies maintaining, or proposing to maintain, aeronautical stations, the frequencies being designated solely for use by all the stations comprising a continuous series, or chain, along a particular airway. Aeronautical stations licensed pursuant to this plan provide adequate service, without discrimination, for all and any aircraft of whatever nature.

The most difficult problem which faced the Commission in regard to the disposition of the continental frequencies was that of the proper principles to apply. Several large companies applied for facilities to establish public systems of point-to-point radio communication in the United States, duplicating and in competition with the wire systems. A large number of applications also came from private interests desiring to set up more limited systems of communication, such as between chain stores, brokers' offices, mail-order houses and their branches, oil companies, mines, and the like. In some cases, applicants asked for facilities for use in regions and under circumstances where the existing wire systems were inadequate, or where none existed at all. Two opposing interpretations of public interest, convenience, or necessity were thrown into contrast. According to one interpretation, the public utility test should be applied to the extent that no applicant be licensed unless it possessed legal status which would oblige it to serve the entire public on an equal basis. This interpretation would lead to the duplication of the existing wire systems with one or more radio systems between the larger cities, the chief advantage to the public coming through competition between wire and radio. According to the other interpretation, radio would be employed primarily for services which could not be duplicated by wire as a practical matter. In making its allocations to specific services, the Commission has attempted to follow a course midway between these two interpretations. As has been shown, however, domestic public radiotelegraph communication so far has been developed only to a limited extent.

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CHAPTER XV

COMBINATION AND COORDINATION IN PUBLIC UTILITIES

Combination or integration of public service companies has taken place to a marked extent, and in recent years at an accelerated pace. In general the consolidation movement has manifested two distinct tendencies: one in the direction of the combination of two or more companies engaged in one type of business, such as the production and sale of electric energy, gas, or water; and the other in the direction of the combination of two or more companies engaged in supplying different services, such as electricity and gas, passenger and freight transportation, and cable and radio communication. Thus it may be said that combinations in the public service industries, like those in other industries, have been of both the horizontal and vertical types. In most of these industries, the various companies have been combined into local, regional, and even national groupings.

Combinations have been brought about in a number of different ways: (1) through the purchase of one utility by another; (2) by the complete fusion of the properties by merging or consolidating several companies into one new one; (3) through the leasing of one property by another company; (4) through the purchase of the securities of one company by another; (5) through the organization of nonoperating or holding companies to own the securities of several or a number of operating companies; and (6) through the development of agreements among companies for the interchange of equipment, facilities, or services. The most common method of bringing about common control is through the use of the holding company.

The Extent of Combination in the Field of Public Utilities.— The combination movement in the United States has passed through several phases. Among the older utilities, including the steam railroads, these phases trace back nearly a century. In the first several decades of railroad transportation in the

United States, the railroads were small local enterprises with little connection with other railroad companies. Gradually these properties were gathered into relatively small systems, often with public approval and encouragement.

Later, the combination of railroads into larger systems and the development of communities of interest between railroads and other transportation companies and financial institutions met with public opposition and hostility, and the railroads were subjected to the provisions of the Act to Regulate Commerce of 1887, the Elkins Act of 1903, the Hepburn Act of 1906, the Mann-Elkins Act of 1910, and other railroad-regulatory laws which sought, among other things, to curb railroad consolidation and monopoly power. The efforts of the railroads to combine in order to limit inter-railroad competition through traffic associations were held by the United States Supreme Court in the Trans-Missouri Traffic Association case in 1897 and in the Joint Traffic Association case in 1898 to be combinations in restraint of trade in violation of the Sherman Anti-Trust Act of 1890. In 1904, the attempt to combine the Northern Pacific and the Great Northern and other competing railroads through the organization of the Northern Securities Company to own the controlling interest in the competing properties also was held to be a violation of the Sherman Act. The same law was invoked to dissolve the combination of the Union Pacific and Southern Pacific systems, and the combination of railroads, electric railways, steamship lines, and public utilities comprising the New York, New Haven & Hartford system. Later, the Clayton Anti-Trust Act of 1914 went even further in seeking to enforce competition between transportation corporations by preventing combinations which would substantially lessen competition and tend to create monopoly.

The next phase of railroad consolidation took place following the outbreak of the World War in 1917 when the railroads were taken under the United States Railroad Administration to be operated as parts of a national integrated system. Every effort was made to lessen competition and to combine railroads, temporarily at least, into a nationwide system under governmental operation and control.

Following the World War, the combination or consolidation of railroads was fostered by Congress through the enactment of

the consolidation provisions of the Transportation Act of 1920 which directed the Interstate Commerce Commission to prepare a plan for the voluntary consolidation of the railroads of the United States into a limited number of systems, which should, however, keep open existing channels of trade and preserve competition among the consolidated systems. The Act of 1920 permitted the pooling of railroad traffic or earnings and the acquisition of one carrier by another, subject to the approval of the Interstate Commerce Commission.

More recently the consolidation of railroads and the coordination of various instrumentalities of transportation have been two of the most important controversial problems in transportation economics. It is urged that coordination of railroad, steamship, highway, and air transportation be brought about through the use of each form of transportation in services in which it is relatively more efficient than other facilities under a comprehensive system of public regulation in intrastate and in interstate commerce. A number of plans of coordination have been developed in various fields of transportation, and further developments may confidently be expected in the near future when a more adequate and comprehensive policy of public regulation of intrastate and interstate commerce finds expression in improved legislation.

Coordination in transportation can be brought about in several ways:

1. Through the ownership and operation of other forms of transportation facilities by railroad companies, the largest transportation utilities;
2. Through the ownership and operation of other means of transportation by subsidiary companies owned by the railroads;
3. Through the acquisition of stock by railroads of other transportation companies in sufficient amount to control the policies and practices of such companies;
4. Through the arrangement by the railroads for services to be performed by other transportation companies through agency contracts;
5. Through the establishment of joint-rate and through-route arrangements by various types of transportation companies so as to give shippers and consignees the advantages of combinations of railroad, steamship, highway, and air transportation, as

required, at all-inclusive rates and under through movement; and

6. Through the organization of transportation companies furnishing railroad, steamship, highway, and air transportation, or combinations of several or all of these services, under one management.

Combination in the Electric Light and Power Industry.—Tendencies towards consolidation of electric light and power companies into larger and larger units have constituted a marked trend in the development of the electric light and power industry. There is as yet no evidence of a definite trend towards control by a single nationwide holding company, but increasing concentration of control has characterized the developments during the past two decades. In 1914, the holding company was not an important factor in the electric utility field, large local corporations and management companies then dominating the industry. By 1924, however, as a study made by the Federal Trade Commission showed, holding-company groups controlled approximately two-thirds of the industry. In that year, companies in the General Electric Company group controlled approximately 13 per cent of the industry; 6 other large holding groups, 28 per cent; and other holding companies, about 24 per cent.[1]

During the period since 1924, still further concentration of control has taken place. Control of some large corporations, still independent in 1924, has been acquired by holding-company groups, and in many cases two or more holding companies have been brought under the control of a larger holding company. Also, a number of smaller holding-company groups were formed in this period. Based upon the quantity of electric energy generated, 16 large holding-company groups controlled over three-fourths of the privately owned industry in the years 1929, 1930, and 1932; 25 small holding companies controlled an additional 2 per cent, making a total of 78 per cent controlled by holding companies. In 1924, the most important group, the General Electric, controlled 13 per cent of the total quantity of electric energy generated by private companies; but in 1929, 1930, and 1932, the United Corporation group controlled about 20 per cent. Three groups, the United Corporation group,

[1] Federal Trade Commission, "Utility Corporations," Senate Doc. 92, 70th Cong., 1st Sess., Part 72-A, p. 36.

with about 20 per cent, the Electric Bond and Share group, with 14 per cent, and the Insull interests, with over 11 per cent, together controlled about 45 per cent of the total for the entire privately owned electric utility industry.[1] Table 40 shows the quantity of electric energy generated, in kilowatt-hours, by each of the principal holding companies, and by groups for other holding companies, large local companies, and small local companies, in 1929, 1930, and 1932.

The percentages shown in Table 40 understate somewhat the importance of holding companies, due to the fact that many of them have in addition substantial minority interests in other companies not included in their groups. For example, the United Corporation owns a minority interest (2.8 per cent) in the voting stock of Consolidated Gas Electric Light & Power Company of Baltimore; Niagara Hudson Power Corporation, 29.7 per cent of Central Gas & Electric Company; the North American Company, 25.8 per cent, and Standard Gas & Electric Company, 10 per cent of Pacific Gas & Electric Company; and the North American Company, 17.9 per cent of the Detroit Edison Company. These four companies together generated 6.2 per cent in 1929, 7.5 per cent in 1930, and 6.8 per cent in 1932 of the total quantity generated, in kilowatt-hours, in the United States during those years.[2]

The Federal Trade Commission has pointed out that the possibility of effecting savings by connecting existing local properties with transmission lines and of merging such connected local companies to form a single operating system has resulted in the growth of larger operating companies, both among independent companies and those under holding-company control. Frequently, desirable operating companies were so located that they could advantageously be added to each of two or more holding-company systems and the competitive bidding which ensued often led to the payment of extravagant prices for the controlling stock of such companies. Also, in many cases, control of operating companies was obtained indirectly by acquiring control of the controlling holding companies. Thus, holding company was pyramided upon holding company and vast utility systems were brought under common control.

[1] *Op. cit.*, p. 37.
[2] *Ibid.*, pp. 38–39.

TABLE 40.—QUANTITY OF ELECTRIC ENERGY GENERATED IN KILOWATT-HOURS BY HOLDING-COMPANY GROUPS, LARGE LOCAL COMPANIES, AND SMALL LOCAL COMPANIES IN 1929, 1930, AND 1932, RANKED ACCORDING TO QUANTITY GENERATED IN 1929

Group	Quantity generated (1,000,000 kw.-hr.)			Percentage of United States total		
	1929	1930	1932*	1929	1930	1932
United Corporation group:						
Commonwealth & Southern Corp	5,789	5,205	4,467	6.7	5.8	5.9
Niagara Hudson Power Corp	5,501	5,105	4,557	6.3	5.7	6 0
United Gas Improvement Co	3,756	3,747	3,189	4.3	4.1	4.2
Public Service Co. of New Jersey	1,802	1,871	1,784	2.1	2 1	2 4
Columbia Gas & Electric Corp	1,203	1,158	991	1.4	1.3	1 3
Total	18,053	17,088	14,990	20.8	19.0	19.8
Electric Bond and Share Co.:						
American Power & Light Co	4,717	4,597	3,310	5.4	5 1	4.4
American Gas & Electric Co	3,820	3,723	2,913	4 4	4 2	3.8
Electric Power & Light Corp.	2,156	2,133	1,753	2 5	2 4	2.3
National Power & Light Co.	1,776	2,452	2,334	2 0	2 7	3.1
Total	12,471	12,905	10,312	14.3	14 4	13.6
Insull interests:						
Commonwealth Edison Co.	3,826	3,246	2,056	4.4	3 6	2.7
Middle West Utilities Co	3,218	3,371	2,701	3.7	3.7	3.6
Midland United Co	785	687	809	.9	.8	1.1
State Line Generating Co	504	1,039	940	.6	1.2	1.2
Super Power Co. of Illinois	451	671	1,192	.5	.7	1.6
Public Service Co. of Northern Illinois	184	641	622	.2	.7	.8
Western United Corp.	†	†	76	.....	.....	.1
Total	8,970	9,657	8,399	10.3	10 7	11.1
North American Co., the	6,513	4,928	4,243	7 4	5.5	5.6
Consolidated Gas Co. of New York	4,678	4,983	4,957	5 4	5.5	6 5
Standard Power & Light Co. (Byllesby)	4,308	4,354	3,712	5 0	4 8	4.9
Associated Gas & Electric Co.	2,508	2,460	1,791	2 9	2 7	2 4
Stone & Webster, Inc.	2,322	2,385	1,757	2.7	2.7	2.3
American Water Works & Electric Co., Inc	1,904	1,841	1,431	2.2	2.1	1.9
Duke Power Co.	1,776	1,546	1,320	2.0	1.7	1.7
Cities Service Co	1,683	1,563	955	1.9	1.7	1 3
New England Power Association	1,354	1,263	1,485	1.6	1.4	2.0
United Light & Power Co	1,300	1,309	1,087	1.5	1.5	1.4
Central Public Service Corp	709	758	505	.8	.8	.7
Utilities Power & Light Corp	603	533	381	.7	.6	.5
North American Light & Power Co	583	628	499	.7	.7	.7
Total	30,248	28,556	24,130	34.8	31.7	31.9
Total above	69,744	68,208	57,833	80.2	75.8	76.4
Other holding companies	1,780	1,862	1,809‡	2.1	2.1	2.4
Holding company total	71,524	70,070	59,643	82.3	77.9	78.8
Large local companies	10,528	11,977	10,129	12.1	13.3	13.4
Small local companies	4,900	7,904	5,920	5.6	8.8	7.8
Total privately owned	86,953	89,951§	75,692‖	100.0	100.0	100.0

* *Electrical World.*
† No data available.
‡ Partly estimated for 1932.
§ Geological Survey.
‖ U. S. Bureau of the Census.
Source: Federal Trade Commission, "Utility Corporations," Senate Doc. 92, 70th Cong., 1st Sess., Part 72-A, p. 38.

The Commission classified the types of holding-company groups as follows: (1) the diversified investment type, in which the utilities controlled do not constitute one continuous chain or network in contiguous territory; (2) the large connected type, in which the utilities controlled lie wholly, or for the most part, in one contiguous network; (3) the large-city type, in which the utilities controlled serve cities and contiguous territory; and (4) super-holding companies, in which whole systems are brought under common control.[1]

Combinations in the Gas Industry.—Combination in the gas industry, both of manufactured and natural gas companies, has not resulted in so great a concentration of control as we have seen in the electric light and power industry, although similar tendencies in development have been apparent. The Federal Trade Commission survey showed that in 1930, companies controlled by 44 holding companies produced 66.4 per cent of the total manufactured gas, and 23.3 per cent of the total natural gas produced in the United States in that year. The Electric Bond and Share Company group was the leading group in the production of natural gas, with 7.4 per cent of the United States total; the United Corporation group second, with 4.2 per cent; and Cities Service Company third, with 3.7 per cent. The United Corporation group ranked first in manufactured gas production, with 12.1 per cent of the United States total; and the Insull group second, with 10.5 per cent. Other important groups in 1930 were American Light & Traction Company, with 6.9 per cent; Central Public Service Company, with 5.3 per cent; and Associated Gas & Electric Company, with 4.5 per cent of the total United States production of manufactured gas.[2] Table 41 shows the quantity of manufactured and natural gas produced by the principal holding-company groups and for other holding-company groups and independent producers during 1930.

The Federal Trade Commission's inquiry disclosed the fact that 15 holding-company groups controlled 40,149 miles, or 80.30 per cent of the natural-gas trunk pipe lines of the entire country in 1932. Chief among these were Columbia Gas & Electric Corporation, with 12,347 miles; Cities Service Company, with 6,059 miles; Electric Power & Light Corporation, with

[1] *Op. cit.*, pp. 84–118.
[2] *Ibid.*, pp. 47–49.

TABLE 41.—QUANTITY OF MANUFACTURED AND NATURAL GAS PRODUCED BY THE PRINCIPAL HOLDING-COMPANY GROUPS, AND FOR OTHER HOLDING-COMPANY GROUPS AND INDEPENDENT PRODUCERS DURING 1930

Group	Produced (in M.C.F.)			Percentage of United States total		
	Natural	Manufactured	Total	Natural	Manufactured	Total
Electric Bond & Share Co.:						
Electric Power & Light Corp.	136,993,079	102,755.6	137,095,834.6	7.1	*	6.1
American Power & Light Co.	5,633,352	5,568,623.8	11,201,975.8	.3	1.8	.5
National Power & Light Co	.....	2,036,209 3	2,036,209.3	.....	.6	.1
Total	142,626,431	7,707,588.7	150,334,019.7	7.4	2.4	6.7
United Corporation group:						
Columbia Gas & Electric Corp.	80,613,618	2,148,659	82,762,277	4.2	.7	3.7
Commonwealth & Southern Corp	.....	9,281,237.1	9,281,237.1	.....	2.9	.4
Niagara Hudson Power Corp.	19,186	5,219,428.8	5,238,614.8	*	1.7	.2
United Gas Improvement Co., the	.....	21,420,152.9	21,420,152.9	.....	6.8	1.0
Total	80,632,804	38,069,477.8	118,702,281.8	4.2	12.1	5.3
Insull group:						
Middle West Utilities Co.	2,485,644.9	6,168,653.4	8,654,298.3	.1	2.0	.4
Central & Southwest Utilities Co.	159,462	131,749	291,211	*	*	*
Midland United Co.	11,358	5,401,837.4	5,413,195.4	*	1.7	.2
Peoples Gas Light & Coke Co., the	.....	21,313,924	21,313,924	.....	6.8	.9
Total	2,656,464.9	33,016,163.8	35,672,628.7	.1	10.5	1.5

* Less than one-tenth of 1 per cent.

TABLE 41 (*Continued*).—QUANTITY OF MANUFACTURED AND NATURAL GAS PRODUCED BY THE PRINCIPAL HOLDING-COMPANY GROUPS, AND FOR OTHER HOLDING-COMPANY GROUPS AND INDEPENDENT PRODUCERS DURING 1930

Group	Produced (in M.C.F.)			Percentage of United States total		
	Natural	Manufactured	Total	Natural	Manufactured	Total
Cities Service Co.	71,928,608	1,887,502.5	73,816,110.5	3.7	.6	3.3
Standard Oil Co. (N.J.)	29,715,060	4,804	29,719,864	1.5	*	1.3
Standard Gas & Electric Co.	25,677,881	6,472,464.8	32,150,345.8	1.3	2.1	1.4
National Fuel Gas Co.	20,087,214	989,110	21,076,324	1.0	.3	.9
Lone Star Gas Corp.	12,023,810	560,733.3	12,584,543.3	.6	.2	.6
United States Steel Corp.	8,930,080	27,037,954	35,968,034	.5	8.6	1.6
Appalachian Gas Corp.	8,721,806	....	8,721,806	.5	.....	.4
Utilities Power & Light Corp.	7,923,630	12,274,195	20,197,825	.4	3.9	.9
Barnsdall Corporation	6,948,708	....	6,948,708	.4	.....	.3
Minnesota Northern Power Co.	5,696,580	102,883	5,799,463	.3	*	.3
Inland Utilities, Inc.	5,574,892	....	5,574,892	.3	.....	.3
Tri-Utilities Corp.	5,273,276	1,611,894.5	6,885,170.5	.3	.5	.3
Western Public Service Corp.	4,269,795	....	4,269,795	.2	.....	.2
North American Light & Power Co.	4,253,136	3,385,588	7,638,724	.2	1.1	.3
Southwest Gas Utilities Corp.	2,256,285	....	2,256,285	.1	.....	.1
Union Gas Corp.	1,816,277	....	1,816,277	.1	.....	.1
Other (25 companies)	5,376,759.4	76,019,341.1	81,396,100.5	.2	24.1	3.5
Total above	452,389,497.3	209,139,700 5	661,529,197.8	23.3	66.4	29.3
Other holding and independent companies	1,491,031,502.7	105,804,299.5	1,596,835,802.2	76.7	33.6	70.7
Total United States	1,943,421,000.0†	314,944,000.0‡	2,258,365,000 0	100.0	100 0	100.0

* Less than one-tenth of 1 per cent.

† Department of Commerce.

‡ American Gas Association.

Source: Federal Trade Commission, "Utility Corporations," Senate Doc. 92, 70th Cong., 1st Sess., Part 72-A, p. 47.

4,947 miles; Southwestern Development Company, with 4,419 miles; and Lone Star Gas Company, with 4,121 miles; these amounts being 24.69, 12.12, 9.89, 8.84, and 8.24 per cent, respectively, of the total miles of trunk line in the United States.

Combination and Coordination in Electric Railway Transportation.—The tendencies toward and away from combination in the electric railway industry are conflicting and confusing. In the earlier years, many urban and interurban electric railway properties were consolidated into large systems serving several cities or considerable sections of the country. Later, electric railways were combined with electric light and power utilities into composite utility properties. The electric railways, however, due to the competition of steam railroads, motorbuses, and private automobiles, fell upon evil days financially and many of the public utility combinations segregated the traction properties from the rest in order to avoid the impairment of the earnings of all the properties because of losses suffered by the electric railways. Many utility companies disposed of their traction interests entirely.

Another tendency in the field of electric railway transportation has been the acquisition of urban and intercity motorbus facilities by the electric railway lines. Many electric railways have either wholly or partially abandoned their trackage and cars and have adopted motorbuses as substitutes. Others use motorbuses and trucks to supplement the electric railway passenger and freight services. A few have acquired taxicab companies as part of a comprehensive program of coordination.

A further tendency has been the development of connections between the heavy-duty electric railways and the steam railroad systems of the United States. A few large electric railways, such as the Pacific Electric, have been absorbed into steam railroad systems. Others, such as the Chicago, North Shore & Milwaukee; the Chicago, South Shore & South Bend; the Illinois Terminal, and a number of others, have remained independent of the steam railroad systems but have joined with them in offering joint service, with through routes and rates, as parts of the general railway transportation system of the United States.

Combination in the Water Service Utilities.—Waterworks utilities, more commonly than other utilities, are owned and

operated by municipalities. For this reason the combination movement has made less progress in water service companies than in other public utility enterprises. Water districts, including the waterworks of a city and surrounding metropolitan areas, are found in several parts of the United States, but these can scarcely be considered to be combinations upon a large scale. The most important combination of waterworks companies is that of the American Water Works and Electric Company, Inc. This system comprises 49 water companies, which operate in 16 widely scattered states and in Cuba. In 1931, 42 of these companies served a population of 2,368,950 using 48,667,661,000 gallons of water.[1]

Combination in the Communication Utilities.—In the communication utilities combination has proceeded further than in other utilities, the bulk of the telephone business being carried on by one system; and the telegraph, cable, and radio business by a very few large systems. The consolidation movement in most utilities has received much impetus from the fact that in this way substantial economies may be realized and increased efficiency attained but in the communication utilities consolidation has been essential to efficient operation and the development of universal service. This is due to the fundamental nature of the communication services. One may receive a complete electric service from the company which serves the area in which he happens to reside and it is of no direct concern to him, except in so far as it may affect his rates, whether or not his neighbors or acquaintances in the same city, and certainly in a distant city, are also users of electric service. However, one's ability to communicate with others, whether in his home city or in other cities, is dependent upon the provision of universal communication service. In voice communication, this requires a single system which interconnects all users; and in record communication, a system which contacts all points to and from which communication is desired. If there are competitive systems, either they must all be universal in scope or there must be effective coordination between them.

In a sense the telephone industry is the most highly integrated of the public utility industries. There are, it is true, many

[1] Relation of Holding Companies to Operating Companies in Power and Gas Affecting Control, House Report 827, 73d Cong., 2d Sess., Part 3, p. 45.

telephone companies but the bulk of the telephone business is conducted by the Bell System and there is very little competition in the telephone industry in the sense that two or more companies serve the same subscribers. Almost without exception, the local telephone service is furnished under monopoly conditions and where two or more companies operate in the same general territory there is a division of territory between them, compelled either by law or by regulatory commission, rather than competition in the same community. Local telephone service in practically all of the larger cities and towns of the United States is furnished by the Bell System, as is most of the toll service. From 1921 to 1934, combinations among telephone companies engaged in interstate communication were subject to the approval of the Interstate Commerce Commission. They are now subject to the Federal Communications Commission.

Combinations of telephone companies operating in different communities have been effected for economic and financial reasons similar to those which have been responsible for consolidation in other public utilities, although other reasons of a technical nature in part explain the tendency towards national monopoly. A national telephone service is best provided by companies under common control. There is no separate toll telephone system as distinct from an exchange system. The same instruments and much of the same equipment, as well as certain of the operating personnel, are employed in the performance of both services. Theoretically, a national telephone system could be set up consisting of separately owned local units in physical connection with each other, but the service would be neither as efficient nor as economical. Physical connection of telephone companies raises more numerous and more complex problems than physical connection of railroad transportation systems. A carload of freight may be handled by several different companies before it reaches destination but in each case all the property, facilities, and operation remain in the control of the owning company and its operating staff. No property intended for the benefit of the customers of one company is put to the exclusive use of another company. A telephone company, however, does not supply a service like transportation, or even like telegraphic communication. It merely furnishes a circuit which

enables one subscriber to communicate with another. This is true whether the two parties live in the same community or in communities separated by thousands of miles. In order, therefore, that one subscriber may be enabled to communicate with a distant subscriber, a circuit must be set up which is continuous and unbroken; it must be for the exclusive use of these two parties; and while it is being used by them, it is not available to any others for telephonic communication. To do this satisfactorily, the operators making up the circuit must have absolute control of the necessary circuits over the whole distance; the operator at the starting point having control of, or perfect working harmony with, all operators of the trunk lines and exchange lines necessary to the completion of the circuit. Accordingly, physical connection between telephone companies from an operating standpoint demands the exclusive use by one company of a part of the facilities and operating staff of another, regardless of the latter's need for the use of such property and of how small surplus facilities might be. It is true that most of the communities not served directly by the lines of the Bell System are embraced in the national telephone system through interconnection between the Bell and local independent telephone companies but in many respects such systems, although many have extensive toll lines, may be considered terminal systems for the toll service. The bulk of the toll circuits are, and must be, under the control of one organization. This is true not only from an operating standpoint but also from that of efficient and economical organization of the service, which requires the establishment and maintenance of many trunk circuits as well as circuits to outlying points.

The necessity for universal telegraph systems inevitably has resulted in the consolidation of telegraph companies into fewer and fewer systems. Many early consolidations were of the end-to-end type, as necessary in telegraph communication as in railroad operation, since every transfer at a junction point meant an additional transmission and reception, which increased the costs, the time required to reach destination, and the probability of error. Furthermore, efficient and economical organization of the telegraph service was dependent upon the creation of large systems so that service between traffic centers could be handled by installing expensive high-speed trunk circuits, with less expensive circuits to serve many scattered points. Other

combinations were effected to eliminate destructive competition by companies organized in many cases to compete for the traffic only on the profitable routes. Consolidation followed consolidation until eventually there were only two large telegraph systems, the Postal and the Western Union. Since its incorporation in 1851, through purchase, lease, or stock ownership, the Western Union has brought under its control 537 telegraph and cable corporations and properties. Many considerations point to the desirability of establishing a domestic telegraph monopoly.

It has been pointed out that there are in the United States two large telegraph systems; the Western Union and the Postal, which compete with each other in all the states and the District of Columbia; and the small telegraph systems which offer them no substantial competition. For the most part the competition between the two large systems is an unequal competition, the Western Union being by far the larger system. On Dec. 31, 1932, the Western Union had 218,635 miles of pole line, 1,899,174 miles of wire, and 21,950 telegraph offices; and the Postal telegraph and cable system, 33,969 miles of pole line, 438,970 miles of wire, and 3,475 telegraph and cable offices. During 1932, the Western Union transmitted an average of 7,542,300 telegraph revenue messages monthly; and the Postal, 2,262,864 telegraph messages and 80,911 cable messages, monthly.[1] The Postal serves all the larger cities of the United States and some 750 small towns not served by the Western Union, but the latter company serves 14,500 points not served by the Postal. The Postal has extended its system to many points in which branch telegraph offices cannot be profitably maintained by negotiating commission-agency contracts with independent telephone companies. On Dec. 31, 1934, it had contracts with 266 telephone companies, which handled Postal telegrams from 1,527 telephone offices. In addition, 11,000 Standard Oil service stations throughout the United States were equipped to accept Postal telegrams. Western Union also had some 15,500 telegraph-agency stations on Dec. 31, 1934.

The greater universality of the Western Union system has always been its principal asset in competition with the Postal.

[1] Preliminary Report on Communication Companies, House Report 1273, 73d Cong., 2d Sess., pp. 93–94.

Because of this, it has been able to meet Postal competition, even though Postal's intrastate rates in 38 states are lower than those of Western Union. Probably the principal contributing factor to the universality of the Western Union system has been the negotiation of exclusive contracts with the steam railroads of the country. These arrangements have been mutually beneficial. To the railroads, they have contributed a telegraph service for the transmission of train orders and to the telegraph company, rights of way for pole lines, exclusive entry into the terminals, and contact with a multitude of widely scattered towns, few of which could support separate branch telegraph offices. Western Union has exclusive contracts with 185 railroad systems; Postal has contracts with some 12 railroads, only 5 of which are exclusive. Because of these facts, the Postal, in attempting to reach a large number of the 73,000 points listed in its tariff book, must either deliver messages over long-distance telephone, in which case a large proportion of the toll must go to the telephone company, or transfer the messages to Western Union, in which case the latter company takes a large share of the toll. The Western Union also has many more exclusive contracts with hotels, clubs, and others, than has the Postal.

For a long period the Postal confined its attention mostly to telegraph traffic between the larger cities where it competed quite successfully with the Western Union. This traffic amounts to about 80 per cent of the total domestic telegraph traffic and of it, Postal receives about 20 per cent. However, with changes in the policy of the company, aimed at the creation of a universal system similar to that of the Western Union, the Postal has incurred increasing costs without corresponding increases in revenue. The recent depression, with its serious effects upon telegraph earnings, has weighed heavily upon the Postal but in the eyes of many, it has merely hastened the coming of an eventuality which has long seemed inevitable.

Competition in the telegraph industry is in many respects as illogical as competition in the telephone industry, in that true competition between the two large telegraph systems would involve even more uneconomic duplication of offices, equipment, and personnel than already exists. There are many aspects in the present competitive situation which are undesirable from

the viewpoints of both the public and the companies. The principal ones may be summarized as follows:

1. Competition tends to depress unduly the net revenues of both companies, since due to duplication the total costs are higher than need be to carry a given volume of telegraph business.

2. Competition exists for the most part only in the larger cities where duplication of offices, equipment, and personnel is required; this results in a division of revenues from the lucrative traffic regions, and renders each less capable of extending its service to the nonlucrative regions, thus resulting in a less universal telegraph service than otherwise could be had.

3. Competition in the leased-wire and time-wire service renders the telegraph companies less capable of meeting the competition of the American Telephone and Telegraph Company in the furnishing of such services.

Because of the facts above outlined, many look upon consolidation as the only permanent solution for the present difficulties of the telegraph companies, especially those of the Postal Telegraph-Cable Corporation, which is in receivership. However, there are certain problems which would have to be solved in bringing about a consolidation satisfactory to the companies and with adequate protection of the public interest. In the first place, telegraph consolidation could not be effected without realignment of the cable systems, because of common ownership and physical and commercial coordination of the telegraph and cable services. This would involve a consideration of the adequacy of protection of the public interest in matters of rate regulation, since the control of a United States commission over international rates could under no circumstances be made complete. What to do with the radiotelegraph services under such a development would also be an important problem because of the ownership of some of these services by certain wire systems and the coordination of others with other wire systems. In the second place, the question could be raised as to whether the telegraph service would be developed as extensively, or intensively, under monopoly control as under competition. In the third place, most of the economies of consolidation would of necessity result from the elimination of duplicate personnel. And in the fourth place, questions of national security would be raised by our military authorities, owing to the

intimate relationship of the communication services to national security and to the fact that certain of the companies have important foreign holdings.

Under present laws, consolidation of the telegraph companies would not be legal, although permissive legislation has been advocated by important groups, including the Federal Communications Commission. While it would be difficult to arrange the details of a consolidation plan which would be satisfactory to the companies and which would also adequately protect the public interest, certainly where the need is so great, this could be done under the initiative of the companies and the control of the Commission, whose function it is to protect the public interest.

In the field of international telegraph communication, the relatively small volume of traffic and the high costs of providing service have restricted the development to a few large companies, whether cable or radio. Competition between cable companies not only leads to uneconomic duplication of cable facilities but also is instrumental in bringing about wasteful duplication of land-telegraph facilities, since successful cable operation is dependent upon adequate and efficient land-line connections. As we have seen, the principal reason for the creation of the Postal Telegraph system was to provide connections to interior points for the Commercial Cable Company. Its domestic telegraph business was developed necessarily because it could not be operated profitably merely as a terminal system for the cable system. If a domestic telegraph monopoly were created, there would in all likelihood follow a new alignment of the cable systems. Radio companies engaged in international communication must either have facilities of their own to connect with interior points or rely upon their competitors, the wire companies, for pickup and delivery service.

The combination of companies furnishing different types of communication services has not proceeded far, the principal exception to this general statement being the combination effected by the interests which have built up the International Telephone and Telegraph system. This system is equipped to furnish a coordinated service, consisting of land-telegraph, cable, radiotelegraph, and telephone communications, although its present activities by telephone are almost wholly confined to developments in and between foreign countries. It controls

the Postal Telegraph system, the Mackay cable companies in the Atlantic and the Pacific, the All America Cable system serving the West Indies, Central and South America, and the Mackay Radio and Telegraph Company, engaged in radio communication with ships at sea and with foreign countries, as well as in domestic radiotelegraph communication. The principal argument in favor of consolidations of this type is that a complete communication service, which involves the transmission of a message from the sender to the party for whom it is intended, often may be furnished most economically and efficiently by the coordination of different services. However, such coordinations can be, and have been, effected by contracts between companies separately owned.

One of the most interesting, and perhaps the best known, of the coordinations which have been effected between different communication services is that of the telephone and telegraph in domestic telegraphic communication. By arrangement between the Bell telephone companies and the telegraph companies, telegraph messages may be communicated by telephone to the telegraph office where they are transmitted to the telegraph office located in the town or city of destination, from which office they may in turn be communicated by telephone to the parties for whom they are intended, the charges of the telegraph companies being included in the telephone bills. The importance of such arrangements in cities where the telegraph companies have offices is that they reduce messenger costs and thus the over-all cost of telegraph service. In smaller places they make possible telegraph service which otherwise could not be provided, since there are many towns in the United States to and from which the volume of telegraph communications is not great enough to warrant the establishment of separate telegraph offices. Many such places are served by telegraph offices located in railroad stations where by arrangements between the telegraph and the railroad companies, public telegraph communication, as well as the private service for the railroad company, is carried on by the station agents; others have had no telegraph service at all, or have lost what they previously possessed through the abandonment of public telegraph service at the railroad stations. How to reach such places has always been a problem for the telegraph companies. Recently they have negotiated many contracts

with local independent telephone companies whereby telegraph messages may be received and delivered by telephone. The local company, like the station agent of a railroad company, acts as agent for the telegraph company. The messages are telephoned to the local telephone exchange whence they are transmitted by telephone, or in some instances by printing-telegraph machines, to the nearest office of the telegraph company, where they are handled in the usual manner. The local telephone companies also receive messages from other than telephone subscribers over the counters at their local exchanges. Incoming telegrams are delivered by telephone or, if necessary, by messenger. The responsibility and liability for the transmission and delivery of the telegraph messages are at all times upon the telegraph company, the telephone company merely acting as agent.

The coordination of telephone and telegraph service in the handling of messages reduces operating costs and enables the establishment of a more nearly universal telegraph service. In addition, cooperation between the telephone and telegraph companies makes possible a more complete utilization of circuit facilities. As we have seen, technical developments have enabled the superimposition of telegraph circuits upon telephone circuits in such a manner that the same wire circuit may be used simultaneously for both telephonic and telegraphic communication. The American Telephone and Telegraph Company has contracts with both telegraph companies under which the latter companies lease from the former by-product circuits and necessary equipment.

For much the same reasons that the land-telegraph and cable services have been developed together, the transoceanic radio services are coordinated with the land-telegraph systems of the United States. Such coordination is mutually beneficial. It gives to the radio collection and delivery service at interior points, without the necessity of duplicating the systems of the land-telegraph companies; and to the telegraph companies, contacts with points not directly reached by wires, especially wires of American companies, and with ships at sea. From the standpoint of the public, it adds another efficient means of communication with foreign countries. The radio and wire telegraph services also have been coordinated in the domestic telegraph service.

Attempts have been made from time to time to bring different agencies together under common control, in order to effect more perfect coordination, but so far public opposition has defeated such attempts where it was believed that the effect would be substantially to lessen competition between them. In 1910, the American Telephone and Telegraph Company obtained control of Western Union but this control aroused so much opposition on the ground that it would create a monopoly of domestic communication that, at the suggestion of the Attorney General of the United States, the telephone company, after three years of association, disposed of its holdings of Western Union stock and the two companies have been operated independently ever since. Similarly, a recent attempt to merge cable and radio systems was defeated. Negotiations were carried on between the International Telephone and Telegraph Company and the Radio Corporation of America by which the former was to purchase from the latter the assets of its communications subsidiary, R.C.A. Communications, Inc. Such a merger, however, would have been illegal under the Radio Act of 1927 and attempts to have the law amended failed. Negotiations were later abandoned altogether.

As the matter stands today, further Federal legislation would be necessary before a merger of cable and radio could be effected. Section 314 of the Communications Act of 1934 forbids the consolidation of wire and radio communication systems engaged in interstate commerce or foreign communications if "the purpose is and/or the effect thereof may be to substantially lessen competition or restrain commerce." Section 313 of the same act also declares that "all the laws of the United States relating to unlawful restraints and monopolies and to combinations, contracts, or agreements in restraint of trade are hereby declared to be applicable . . . to interstate and foreign radio communications." The latter provision removes radio from the provisions of the Webb Act of 1918, which permits combinations of persons and corporations in the United States for the purpose of selling American goods abroad.

The Motives Impelling Utilities towards Combination.— The reasons for combining many scattered utility properties of the same or of different types into a single community of interest are various. They differ with the industries, with

economic conditions, and with financial expediency, although a few reasons are generally applicable in the gas and electric utilities. One of the most important of these is the possibility of achieving the advantages of larger scale operation. Small and obsolete types of facilities and equipment may be retired and newer, larger, and more efficient units may be used to better advantage to serve the territory formerly served by independent small units. Economies may be achieved in the use of fuel; supplies and materials may be purchased centrally for all of the properties rather than individually for each unit; labor can be mobilized and used more expertly and more efficiently; facilities and equipment can be interchanged among the units of the combined properties; and the facilities may be located more advantageously with respect to the communities and consumers served. The advantages of interconnecting electric light and power systems, previously mentioned, are of great significance in this connection.

A second reason is to improve the quality of service rendered patrons. The economies of larger scale operation may so reduce operation costs that standards of service, impossible under smaller, isolated-unit operation because of prohibitive costs, may be rendered without increased rates to the consumers, and with increased profit to the utility company. In transportation, longer routes, more frequent headways, and fast service are possible improvements. In the gas utilities, higher and more constant pressure and supply are desirable service improvements. In electric light and power utilities, more dependable service may be provided, and 24-hour electric service may be given in communities which formerly had "twilight-to-dawn" electric service only, or no service at all on account of the high costs of supplying small communities.

A third impelling motive is found in the opportunity afforded to employ specialists and executives of superior ability as compared with those possible in small-unit operation. The larger plan of operation makes it practical to extend the division of labor and to employ qualified specialists in operation, traffic, rate making, sales promotion, accountancy, statistics, law, finance, public relations, and employee relations under the direction of experienced executives.

A fourth motive of combination is the opportunity given to standardize equipment and facilities and to purchase upon

the basis of standard specifications and large units, thus promoting uniformity and high quality of supplies and equipment and reaping the benefits of lower unit prices.

A fifth motive attributed to combination is the improvement of the financial position of the properties. Small public utility companies often experience difficulty in obtaining funds necessary for additions and betterments to their plants. Often, small utility companies are organized and financed initially by local citizens interested in supplying the community with the needed facilities and little difficulty is experienced in raising the first increments of capital. Later, however, after the novelty has worn off, these companies sometimes have difficulty in finding the additional capital required to develop, extend, and improve their plants. The market for the securities of such small utilities is largely a local market and as such is often unduly restricted. Combination of the properties into larger units tends to broaden the market for securities over a section of the country or even throughout all the financial markets of the nation. These financial relationships, however, have been subject to grave abuses.

A sixth motive is found in the advantages to be gained by diversification. The diversification can be attained by combining small utility companies engaged in the same utility service into larger units serving wider territories and a greater variety of consumers, including domestic, commercial, manufacturing, agricultural, and mining consumers. Extending the services of one organization over wider territories also tends to spread the risk, so that it is financially less vulnerable in cases of fire, flood, or other catastrophe which might ruin a smaller local utility serving only the community affected. Similarly, the company's revenues are less likely to be adversely affected by business conditions in one community or a small area. The diversification attained by engaging in several different utility services has the advantage of increasing the variety of services offered under one combined managerial group, so that the same policies may be made for all utilities in the group and each utility be made the complement of the others. Competition may thus be limited and the combined utility companies relieved of the hazard of depending upon one group of customers and upon one type of utility service.

Finally, combination has tended to improve or increase the capacity factor as well as the load factor of the combined utilities, especially desirable achievements in the electric light and power industry, the capacity factor being the ratio of the average load to the rated capacity of the plant. The capacity of a public utility plant must be determined not alone by the peak or maximum load requirements, but provision must be made to handle the peak loads with due allowance for increased peak loads caused by the development of business. Since peak-load demands do not occur simultaneously in all communities, if a number of smaller utility plants are combined under one management or interchange arrangement, the facilities may be pooled and the peak load under combined operation will be less than the sum of the peak loads of the smaller isolated units. Also, the combined plant may safely have a lower rated capacity than the sum of the rated capacities of the smaller units and thus with the same output will have a higher capacity factor. Furthermore, the combination or interconnection of public utility properties reduces or avoids the necessity of maintaining reserve equipment as compared with the equipment reserves required under small-scale operation. In fact, in very large combined or interconnected systems, reserve equipment as such can be dispensed with because the reserve is in the system. This, of course, improves the capacity factor.

The Disadvantages or Dangers of Combination.—The combination of smaller into larger business units in the public service industries, as in other types of business, tends to produce monopoly in the areas served and, if the combinations are of the vertical type embracing several or a number of different utilities, the monopolies may include several different types of services. However, combinations which create monopolies and result in the limitation or complete elimination of competition are not undesirable in the public service industries if accompanied by effective regulation. The duplications of service which accompany the competition of several rivals in supplying the public with necessary services are uneconomically wasteful. More efficient and economical service often can be supplied by a monopoly. The danger is that the combined units may become so large and influential that effective regulation is jeopardized, especially with respect to intercompany payments, a danger

difficult to overcome by strengthening and extending the powers of the regulatory bodies.

A second danger is that the combinations may become so large as to become unwieldy and beyond the capacities of unified management. Just at what point the advantages of combination are offset by the disadvantages of unwieldiness cannot be answered dogmatically, but must be determined by the internal and external problems of management, supervision, and control in each given industry. If the combinations become too large and unwieldy, intricate subdivision of labor and responsibility tends to stultify initiative on the part of members of the organization and to enmesh them in a tangle of "red tape." Associated with this disadvantage of excessive combination and centralization is the difficulty of finding executives of the superlatively high degree of ability required to direct such large enterprises.

A third danger of combination is the risk that the very large, highly centralized, and overorganized enterprises may tend to become hyperconservative and not sufficiently responsive to advances in the arts, due to the desire to protect existing investment in equipment and facilities. However, over against this danger of conservatism sublimated into a vice must be placed the positive advantages enjoyed by large organizations in the ability to engage in research work upon a scale impossible in smaller enterprises.

A fourth danger of combination is the risk of overcapitalization or reckless inflation in the capital structure of the industry. There has been a deplorable tendency to combine a number of smaller units into large ones, the total capitalization of which is greatly in excess of the aggregate capitalization of the individual properties. This practice has been speciously defended upon the ground that the economies and efficiencies of combination tend to reduce costs of operation and to increase earnings sufficiently to justify the increased capitalization. In some cases, it has been alleged that excessive prices have been paid for the properties acquired. In many cases, large profits have been made by those promoting the consolidations, though in others the increased capitalization has been distributed among the stockholders as stock dividends. Defense of the practice of increasing capitalization through the acquisition of properties by combinations in the public utility field has been epitomized by

Mr. Samuel Insull, who in an address before the National Electric Association in 1927 defended this practice in connection with the acquisition of utility properties in Lake County, Illinois, on the ground that when certain properties are necessary to round out public utility systems, the price paid for them, if anywhere within reason, is relatively unimportant, because of the great advantages that result from compact groupings.[1] It is submitted that the expression "anywhere within reason" is too vague a check against overcapitalization and fraud to protect bona fide investors or the public which must pay rates sufficient to support the enterprise.

A fifth danger of combination is the risk that the integration of smaller plants into larger combines may result in the capitalization of the less efficient, worn-out, or obsolete equipment of the smaller utilities which may have to be replaced with new and more efficient equipment after the combination is effected. This results in a double danger of overcapitalization. The utility has paid for the old equipment and must then dismantle some or all of it and install new. The prices paid for small units acquired by the large combinations must reflect this contingency even if the prices paid are within reason. The Railroad Commission of California long ago gave expression to the proper view of this matter when it stated succinctly: "A utility has no right to expect public authorities to authorize the capitalization of junk."[2]

A sixth danger of combination which deserves comment is the effect of consolidation of utilities into large sectional or national groupings upon the contact between the utilities and the public and local authorities in the communities served. The utilities become so large that they tend to become "impersonalized," the local public loses touch with the responsible officers of the utilities, and governmental agencies find it difficult to regulate even such aspects of public utility operation as should be brought under local government control. The late Sir Henry Worth Thornton, in commenting upon this condition in railroad transportation, said that there is danger in the growth of corporations to the size that they become so large and remote that there

[1] INSULL, SAMUEL, "Twenty-five Years of Electric Power," Chicago, 1927.

[2] 2 Calif. R.R. Commission Decisions, 589, 592 (1913).

is no longer anyone for the public to damn when things go wrong or praise when they go right.

Without a doubt, the most unsatisfactory aspect of the combination movement in the gas and electric utilities has been the pyramiding of holding company upon holding company by which a few individuals employing small amounts of their own funds have obtained control of vast utility empires. Many of such consolidations have had little relationship to underlying economies or to considerations of the public interest. They have been effected for purposes of private gain, which has been achieved through the inflation of values, stock manipulation, unfair and unreasonable intercompany payments for goods and services, and through many other methods of exploiting operating companies.

The advantages and dangers of combination among public utilities are real and vital problems which must be considered by utility managers, by investors, by the consumers of the services, and by public regulatory bodies. No vague generalizations pro or con should be permitted to sway judgments. Under what conditions combinations should be undertaken, the prices paid for the properties acquired, the replacement of the old or inferior equipment of the smaller units with new equipment, the organization of the combined properties, the interchange of equipment and services, the issuance of new securities to replace existing capitalization, the payment of stock dividends, the profits of the promoters of the combinations, the rate bases of the combined properties, are all problems which must be considered from the points of view of management, employees, patrons and the public generally, and in each individual case.

The mania for combinations, for "bigger and better" units, for financial complications and overexpansion needs to be curbed but regulatory bodies and the public should not develop a phobia of combinations merely because they are combinations. Moderation should characterize the action of the public utility managements, their patrons, and public regulatory authorities. The tangible benefits of consolidation should, whenever possible, be reaped for the benefit of all; and the dangers of excessive combination and the evils of overcapitalization or extravagant management should be avoided by public regulation. Just where the line is to be drawn in specific instances is a question

to be determined by the exercise of the discretionary powers of competent public utility commissions in the protection of the public interest. It is not a problem to be solved for all utilities, under all conditions, and at all times by specious generalizations.

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INDEX

A

Act to Regulate Commerce, and control of railroad combinations, 366
(*See also* Interstate Commerce Commission)
Adler, H. M., 3
Aeration of water supplies, 140
Alexanderson, E. F. W., 340
All-American Cables, Incorporated, business and revenues, 324–326
types of messages handled, 327
Alternating current, 86
American City, 142
American Electric Railway Association, 183, 222, 223
American Light and Traction Company, 371
American Telephone and Telegraph Company, competition with telegraph, 380
coordination of telegraph and telephone services, 382–383
leases of equipment by, 301
long-distance service and messages, 276–278
private-wire services, 295–296
private-wire telegraph services, 305
proportion of total telephone business handled by, 272–275
radiotelephony services, 278–280
revenues from radio services, 296
ship-to-shore services, 279–280
telegraph messages by telephone, 382
telephotograph services, 296
teletypewriter services, 306
timed-wire services, 311–312
American Telephone and Telegraph Company, toll rate structure, 293–295
transatlantic cables,317
trucks operated by, 163
American Radio News Corporation, 345
American Transit Association, 197
American Water Works Association, 135, 154
American Waterworks and Electric Corporation, 375
Anglo-American Telegraph Company, 317, 318
Anti-merchandising laws for public utilities, 94
Appliances, electric, 93
emphasis upon sale of, by electric utilities, 95
rentals of, by electric utilities, 95
use of, in electric services, 95
Appointment telephone service, 292
Arc lights, 85
Ashwander v. Tennessee Valley Authority, 119*n*.
Associated Gas and Electric Company, 371
Atlantic Communication Company, 339
Automatic relay cables, 326
Automobiles, effect on society, 160–161
manufacturing industry, 156–159
private, 159–161
vehicles produced, 157–158
vehicles registered, 158–159
(*See also* Motorbuses; Motor transportation; Motor trucks)
Aviation services, radio, 362–363

B

Barnsdall Oil Corporation, 254
Bell System (*see* American Telephone and Telegraph Company)
Bennett, James Gordon, 299, 318
Block rates, 44–45, 153
Board of Public Service of St. Louis, 220
Board of Transportation of New York City, 219
Bottled gas, 58
Boulton, Watt and Company, 51
Brandeis, Mr. Justice, 14, 15 '9
Brewer, Mr. Justice, 12
British Marconi, 339–340
Broad Street Subway Conference Board, 218
Brown, Mr. Justice, 12
Brundred Bros. v. P. P. L. Co. 266*n.*
Budd v. New York, 10–12
Bunsen burner, 52
Bus Transportation, 169
Bureau of Mines, study of petroleum losses, 255
  petroleum shipments, 252
Butane, air gas, 58
  production of, 68

C

Cable cars, use of, in urban transportation, 178–179
Cable communication, addresses registered for, 333–334
  automatic relay, 326
  British leadership in, 317
  cipher language permitted in, 334–335
  classes of service offered for, 331–333
  clear language for, 334
  code language permitted in, 334–335
  combinations in, 381
  companies, in South American field, 322–323
    transatlantic field, 319–320
Cable communication, competitive conditions in, 327–328
  connections with West Indies, Central and South America, 320–323
  cost factors in, 328–330
  deferred messages, 331
  direct operation of, 327
  duplex operation of, 326
  economic characteristics of, 327–330
  full-rate cablegrams, 331
  freshening of messages in, 329
  international rules and regulations for, 330–331
  languages permitted in, 334–335
  load factor problems, 329–330
  manual relay of, 326
  night letters, 332
  permalloy cables used for, 326
  rate-making for, 330–333
  rates for, 333–337
  repairs of cables, 329
  secret language permitted, 334
  special services, 332–333
  South American monopoly of, 320–322
  technical development of, 326–327
  transatlantic systems, 317–320
  transpacific systems, 323–324
  types of messages carried, 327
  urgent messages, 331
  volume of business, 324–326
  word count practices, 335–337
Canadian Pacific Railway, 319
Canavan v. City of Mechanicsville, 143*n.*
Carbon black, 75
Carlton, Newcomb, 320
Central America, cable connections with United States, 320–323
Central and South American Company, 321
Central Gas and Electric Company, 369
Central Public Service Company, 371

Central stations, reasons for increase in size of, 102–103
Chamber of Commerce of the United States, 183
Charles Wolff Packing Co. v. The Industrial Court of Kansas, 12–13
Chemical treatment of water supplies, 140
Chicago, Burlington and Quincy Railroad Company v. McGuire, 14
Chicago, North Shore and Milwaukee interurban railway, 374
Chlorination of water supplies, 139
Cipher language, for cable messages, 334–335
Cities, growth of, 176–177
  need for transportation in, 176–177
  number of, by population, 177–178
Cities Service Company, 371
City Club of New York, survey of rapid transit costs, 216
Classes of service, offered in cable communication, 331–333
    radio communication, 354
    telegraph communication, 310–313
    telephone communication, 285–293
Classification of customers, for electric light and power rates, 125
  for manufactured-gas rates, 41
  for rate-making purposes, 32
  and simplicity of rate structures, 32
  for street railway rates, 200
Clayton, John, 51
Clear language, defined for cable messages, 334
Coagulation of water supplies, 139
Code language, permitted in cable messages, 334–335
Coke-oven gas, 56
Columbia Gas and Electric Corporation, 371
Combinations, in cable communication, 381
  in communication utilities, 375–384
  of companies furnishing different communication services, 381–384
  dangers and disadvantages of, 387–391
  effect of Sherman Act on railroad, 366
  in electric light and power utilities, 368–371
  in electric railway transportation, 374
  in gas utilities, 371–374
  holding companies, in the electric light and power industry, 368–371
  increase in the number of, 365
  and integration in the petroleum industry, 257–258
  in interurban electric railways, 374
  means of effecting, 365
  and merger of communication utilities prevented, 384
  motives of, 384–387
  in pipe line transportation, 257–260
  in street railways, 374
  in telegraph communication, 377–381
  in telephone communication, 375–377
  Transportation Act of 1920, and railroad consolidations, 367
  in water supply utilities, 374–375
Commercial Cable Company, 299, 318, 322, 324, 326, 328
Commercial Pacific Cable Company, 324
Commissioner of Corporations of the United States, 256
Common callings or vocations, 1–3
Common carriers, in motor transportation, 164
  motorbuses serving as, 171–172
  as public utilities, 8

Common law, characteristics of, 6–7
Communication Act of 1934, powers of, 360
  provisions concerning broadcasting, 346
Commonwealth and Southern Corporation, 118
Communication utilities, combinations in, 375–384
  (*See also* Cable communication; Telegraph; Telephone; Radio)
Competition, in cable communication, 327–328
  of gas and other fuels, 52
  in motor transportation, 164
  between telegraph and telephone, 380
  of radio and other communication utilities, 352
Conservation of natural gas, 69–70
Consolidated Gas Electric Light and Power Company, 369
Consolidated Oil Company, ownership of pipe lines by, 258–260
Contamination of water supplies, 133
Continental Oil Company, 254
Contract carriers, in motor transportation, 164
Cooke, Morris L., 20
Coordination, of electric railways and motor trucks, 242–245
  in electric railway transportation, 374
  in railway services, 367–368
  of rapid transit and surface transportation, 225–226
  in street railway services, 191–194
Cornell, Ezra, 298
Cost allocation, involved in rate structures, 38–42
Cost factors, in cable communication, 328–330
  classification of, 29
  in electric light and power, 122–124
  in manufactured gas, 35–42
  in natural gas, 78–80
Cost factors, in pipe line transportation, 260–263
  in public utilities in general, 28–29
  in rapid transit transportation, 222–223
  in street railways, 198
  in telegraph communication, 307–308
  in telephone communication, 282–285
  in water supply utilities, 147–148
Costs, customer responsibility for, 29
  fixed, 29
  peak load, 29
Cuba Submarine Telegraph Company, 320
Cuban All-America Cables, Incorporated, 322
Customers, classification of, in electric light and power, 125
  in manufactured gas, 41
  for rate making, 32

D

Day telegraph letters, 310
Deferred message telegrams, 331
Demand, measurement of, for rate-making, 31–32
Demand factors, in gas utilities, 36–37
  in street railways, 199
  in telegraph communication, 307
  in water supply utilities, 148–149
Demand rates, 45, 124
Detroit Edison Company, 369
Diesel engines, use in water pumping, 137–138
Direct current, 86
Direct United States Cable Company, 317
Direct West India Company, 320
Distance rates, of interurban electric railways, 237
  of street railways, 205
  of telegraph communication, 308
  of telephone communication, 292–295

Diversity factor, defined, 30–31
influence on size of central stations, 102
Doherty rate, 124
Duplex operation, of cables, 326
of telegraphs, 301
Dynamos, types of, 86

E

Eastern Extension, Australasia, and China Telegraph Company, 323
Eastern Telegraph Company, 319, 323
Economic characteristics, of cable communication, 327–330
of public utility businesses, 20–22
of radio communication, 350
of telegraph communication, 307–308
of telephone communication, 281–285
of water supply utilities, 131–135
Edison Electric Institute, 87
Electric Bond and Share Company, holding-company group, 371
Electric Home and Farm Authority, creation and purpose of, 122
sales of appliances to rural customers, 99
stimulation of appliance sales, 122
Electric light and power, appliance rentals, 95
appliance sales, 93–95
appliance use and rate levels for, 95
central stations, growth in size of, 102–104
classification of customers for rate-making, 125
combinations in, 368–371
demand charges in rate forms, 124
discovery and development of, 84–87
Doherty rate forms used by, 124
domestic consumption of, 92
domestic rate levels, 92–93
electrification of industry, 95–97
Electric light and power, emphasis upon appliance sales, 95
farm customers and uses, 97–98
Federal projects, 112–122
fuels used, 100–102
future growth of, 88–92
generation and distribution of, 88–92
growth and development of, 87
holding companies in, 109–111
Hopkinson rate forms used by, 124
industrial consumption of, 95–97
industrial uses of, 96
interconnections in, 105–109
interstate movement of power, 107
load factor and costs of, 122
and rates, 123
losses in transmission, 104
municipal ownership of, 111
need for planning in the development of, 113
national policy for, 112–122
objective rate plan for, 127
off-peak rates, 125, 126
origin and development of, 84–87
output and capacities of major systems, 103–104
peak-load influence on demand charges, 123
promotional rates, 126
rate schedules used by, 124
rates for, 122–124
regional power areas for, 109
rural electrification, 97–100
transmission circuits, 105
transmission lines, 104–105
transmission networks, 105
Wright rate forms used by, 124
Electric Power and Light Corporation, 371
Electric Railways (*See* Interurban electric railway transportation; Street railway transportation)
Electric Railway President's Conference, 182
Electric railway transportation, combination and coordination in, 374

Electric railway transportation, use of motorbuses in, 172–173
use of motor trucks in, 242–245
(*See also* Interurban electric railway transportation; Street railway transportation)
Electric Rate Survey, 114
Electrical World, 87, 92, 98
Elevated railways, cost of, 222–223
versus subways, 222
(*See also* Rapid transit transportation)
English Yearbooks, listing of common callings, 2–3
Exchange rates, telephone communication, 285–293
Exchange service, telephone communication, 275

F

Facsimile radio communication, 341–342
Family passes, street railways, 203
Fare levels, street railways, 197–198
Fare practices, rapid transit transportation, 226–227
Fare structures, interurban electric railways, 237
street railways, 200–208
theories of ideal, for street railways, 199–200
Federal aid highways, miles of, 161
Federal Communications Commission, 360
Federal Power Commission, Electric Rate Survey, 114
formation and history of, 113
National Power Survey, 103, 105, 114
Federal power projects, grants for, 115
Federal Radio Commission, description of broadcasting services, 347–348
regulation of radio by, 359
Federal Telegraph Company, 339
Federal Trade Commission, recommendations concerning pipe line companies, 268–269
study of electric light and power combinations, 368
study of gas combinations, 371–374
study of pipe line costs, 261
Field, Cyrus W., 317
Field, Mr. Justice, 12
Filtration of water supplies, 139
Fire protection services of water supply utilities, 143–147
Firestone Tire and Rubber Company, 344
Flat demand rates, 47
Flat rates, 42, 149, 287
French Cable Company, 320, 322
Freight traffic practices, interurban electric railways, 245–247
Freight transportation, by interurban electric railways, 237–248
by motor truck, 161–169
Fuel, quantity used in electrical generation, 100–102
Full-rate cablegrams, 331

G

Gas, degree of use of, by sections, 81–83
liquefied petroleum, 68
manufactured, allocation of costs to users of, 38–42
bottled gas, 58
butane air gas, 58
classification, of costs of, 38
of customers for rate-making, 41
coke-oven gas, 56
commercial and industrial uses and consumption, 62–63
commodity costs, 39
competition with other fuels, 52
consumption of, 60
cost factors, 35–42
customer costs, 39
demand for, 36–37

Gas, manufactured, distribution-demand costs, 38
domestic uses and consumption, 61
early opposition to use of, 51–52
growth and development of, 51–55
growth in output of, 53–54
growth in sales of, 54–55
house-heating by, 62
long-distance transportation of, 37–38
number of companies producing, 53, 81
number of customers, 54–55
oil gas, 57
peak-load problems, 36–37
production of, 59
production-demand costs, 38
propane gas, 58
rates, 35–50
reformed-oil-refinery gas, 57
retort coal gas, 57
space heaters, 62
storage of, 36
uses of, 52
water gas, 55
natural, competition with other fuels, 77
costs of, 72–74
domestic and commercial consumption of, 74–75
future of, 77
future of production of, 69
industrial consumption of, 75–77
interstate shipments of, 72
kinds of, 64
long-distance transportation of, 69, 71
nature of production costs of, 78–80
pipe lines, 70–72
pipe-line compressing station costs, 73
pipe-line construction costs, 72–73
pipe-line maintenance costs, 74
Gas, natural, pipe-line mileage, 72
producing districts, 65
production of, 63, 65–66
production of liquefied petroleum, 68
rates, 78–81
storage of, 80
transportation of, 70–72
uses of, 75–76
variations in rates of, 78
well-drilling for, 64
Gas industry, combinations in, 371–374
Gasoline, natural, production of, 66
uses of, 66–68
Gasoline pipe lines, 254
General Electric Company, contracts with Radio Corporation of America, 340–341
General Electric holding-company group, 368
Generation of electric current, 88–92
Generator capacities, 86–87
German Alliance Insurance Co. v. Lewis, 8, 9*n*.
Globe Wireless, Limited, 344, 362
Gould, Jay, 317
Government operated radios in the United States, 349–350
Great Lakes Pipe Line Company, 254
Great Northern Telegraph Company, 319, 323
Green v. Ashland Water Company, 143*n*.
Gulf Oil Corporation of Pennsylvania, ownership of pipe lines by, 260

H

Halifax and Bermudas Company, 320
Hartford Electric Light Company, 121
Helmont, Jan Baptista van, 51
Hepburn Act, placing pipe lines under I. C. C. control, 265
Highway construction, and motor transportation, 161

Holding companies, reasons for growth of, in the electric light and power industry, 109–111
theory of, 110
types of, in the electric light and power industry, 371
Holmes, Mr. Justice, 18, 19
Hopkinson rate, 124
Horse cars, use in urban transportation, 178
House heating, by gas, 62
House printing telegraphs, 298
Hydro-electric plants, development of, 87

I

Illinois Commerce Commission, industries subject to regulation by, 24
Illinois Terminal interurban railways, 374
Imperial and International Communications, Ltd., 320, 324
Incandescent lights, 85
Indiana Natural Gas and Oil Company, 71
Industrial electrification, 95–97
Insull, Samuel, 389
Insull holding-company group, 369, 371
Integration, and combinations, 365
of the petroleum industry, 257–258
of the telephone industry, 357–376
(*See also* Combinations)
Interconnection in the electric light and power industry, advantages of, 106
defined, 105–106
extent of, 107
illustrations of, 108
misconceptions concerning, 107
nature of, 107–108
Interstate Commerce Commission, conditions necessary to effective regulation of pipe lines by, 270
Interstate Commerce Commission, control of, railroad combinations, 366
pipe line transportation, 265
interurban electric railway tariffs filed with, 248
minimum tender requirements for pipe lines decision, 266–268
order to file pipe line tariffs, 265
pipe line rates filed with, 264
radio broadcasting decision, 346
regulation of motor carriers by, 166, 168
telegraph timed-wire decision, 311–312
Interstate movement, of electric current, 107
of natural gas, 72
International Telecommunication Convention, 330, 352, 354
International Telegraph Union, 335, 336
International Telephone and Telegraph Corporation, 299, 319, 322, 343, 381, 382
Interurban electric railway transportation, advantages and disadvantages in the development of freight transportation, 240–242
coordination and competition with motor trucks, 242–245
development of freight services by, 238–239
fare structure of, 237
freight rates of, 247–248
freight traffic practices of, 245–247
freight transportation services of, 237–248
growth and development of, 229–231
miles of, 231
modernization of passenger services of, 235–237
motorbuses used in, 234–235
passenger transportation services of, 229–237

Interurban electric railway transportation, pick-up and delivery services in, 244–245
present status of, 231–234
reasons for decline of, 232–234
selection of routes for, 230–231
significance and effect of, 229
types of freight carriers in, 239
volume of freight traffic in, 239–240
of passenger traffic in, 235
(*See also* Electric railway transportation)

J

Jackson v. Rodgers, 2
Jitneys, 169
Jones v. Mount Holley Water Company, 143*n*.

K

Kolster radio compass, 343

L

Lamar, Mr. Justice, 8
Languages, permitted in cable communication, 334–335
in telegraph communication, 309
Licensing, of radio applicants in the United States, 361–363
Lilienthal, David E., 120
Liquefied petroleum gas, 68
Load factor, in cable communication, 329
defined, 30
effect on electric rates, 123
in the electric light and power industry, 122
influence on size of central stations, 103
in street railway transportation, 194–196
in telegraph communication, 307–308
Load factor, in telephone communication, 284–285
in radio communication, 352–354
Lone Star Gas Company, 374
Long-distance telephone service, 276–278
Long-distance transportation of natural gas, 71
London and Westminster Gas Light and Coke Company, 51

M

Mackay, John W., 299, 317–318
Mackay Radio and Telegraph Company, 343, 344–345
Madrid International Radio Conference, 356
Magazine of Wall Street, 131
Manual operation of telegraphs, 303
Manual relay of cables, 326
Marconi Wireless Telegraph Company of America, 339
Measured rates, telephone communication, 287
Melville, David, 51
Messenger telephone services, 292
Meter reading, water supply utilities, 142–143
Metering practices, water supply utilities, 140–143
Mexican Cable Company, 311
Mid-Continent Petroleum Corporation, 254
Minckelers, Jean Pierre, 51
Minimum tender requirements, pipe line transportation, 264–266, 270
Miscellaneous fares, street railway transportation, 206–207
Monopoly price, nature of, 26
Monthly passes, street railway transportation, 202
Motorbuses, common carrier services of, 171–172
development of jitney service with, 169
registration of, 170

Motorbuses, use of, by steam railways, 172
  in urban transportation, 172, 186–188
 uses of, 170–171
Motor freight companies, business organization of, 169
 trucks operated by, 163
Motor Haulage Company, trucks operated by, 163
Motor transportation, common carrier motorbuses in, 171–172
 common carriers in, 164
 competition in, 164
 contract carriers in, 164
 coordination of carriers in, 172
 effects of private automobile, 160–161
 freight services in, 161–169
 and highway construction, 161
 industries involved in, 156
 manufacturing industry, 156–159
 motorbuses used in, 169–173
 motor-freight companies in, 169
 motor-truck production, 162–163
 motor-truck regulation, 164–166
 passenger services in, 169–173
 private automobile, 159–161
 regulation of, 164–166
 relation between motor trucks and other carriers in, 167–169
 taxicabs in, 173–174, 192–194
 types of carriers in, 163–164
  of freight services in, 166–167
 vehicles produced, 157–158
 vehicles registered, 158–159
 use of motorbuses, 170–171
   by steam and electric railways, 172–173
  of motor trucks, 163
Motor trucks, common carrier, 164
 competition among, 164
 production of, 162–163
 regulation of, 164–166
 relations with other carriers, 167–169
 types of freight services by, 166–167
Motor trucks, uses of, 163
Municipal Index, 142
Municipal ownership, in the electric light and power industry, 111
 in water supply utilities, 134
Multiplex operation, of telegraphs, 301–303
Munn v. Illinois, 7–8, 9–10, 13
Murdoch, William, 51
Muscle Shoals, 113

N

National Association of Motor Bus Operators, 169, 170
National Automobile Chamber of Commerce, 156, 160, 163
National Electric Light Association, 87
National Fire Underwriters Association, 146
National Recovery Administration, petroleum code, 269–270
National power policy, in the United States, 112–122
National Power Policy Committee, 114
National Power Survey, 103, 105, 114
National Resources Board, 131
Nationwide Survey of Taxicab Regulation, 174
Natural gasoline, production of, 66
 uses of, 68
New England Power Company, 105
New England Water Works Association, 153
Newfoundland Government Telegraphs, 319
New State Ice Company v. Liebman, 14–18
New York Herald, 318
New York and Mississippi Valley Printing Telegraph Company, 298
New York Public Service Commission, attitude toward resale of telephone service, 289–290

Niagara Hudson Power Corporation, 104, 369
Night letter cablegrams, 332
Night telegraph letters, 310
Night telegraph messages, 310
North American Company, 369
North American Radio Agreement, 358–359
North Jersey Transit Commission, 221
Northern Securities Company, 366

O

Objective rate plan, 127
Odor and taste removal from water supplies, 139–140
Off-peak passes, street railway transportation, 203
Off-peak rates, in cable communication, 331–332
  in electric light and power, 125–126
  in gas, 49–50
  in radio communication, 354
  in street railway transportation, 200–205
  in telegraph communication, 310–311
  in telephone communication, 292–293
Oil Creek Railroad, 252
Oil gas, 57
Ontario Hydro-Electric Power Commission, 119
Overseas telephone service, 279

P

P. B. X. telephone service, 289
Pacific Electric interurban railways, 374
Pacific Gas and Electric Corporation, 105, 369
Paducah Lumber Company v. Paducah Water Supply Company, 147
Passenger services, in interurban electric railway transportation, 229–237
Pay station telephone service, 290
Peak load, effect on electric light and power rates, 123
  on rate structures, 29–30
  on street railway transportation rates, 195–197
  (*See also* Load factor; Off-peak rates)
Pennsylvania Joint Rural Electrification Committee, 100
Pennsylvania Power and Light Company, 108
Pennsylvania Public Service Company Law, 22–24
Permalloy cables, 326
Permit cards, street railway transportation, 204
Person-to-person telephone service, 292
Petroleum, concentration of ownership in, 257–258
  crude purchasing companies, 257
  divisions of the industry, 249
  location of refineries, 251–252
  producing districts in the United States, 250–251
  production of, 249–250
  rail shipments of crude, 255
  shipments of crude, 252
  storage of crude, 255
  wastes in storage, 255
Petroleum code, attitude of integrated and independent companies toward, 269–270
Philadelphia Electric Company, 108
Philadelphia Rapid Transit, 225
Philadelphia Real Estate Board, Transit Committee, 216
Phillips Petroleum Company, 254
Pick-up and delivery services, interurban electric railway transportation, 244–245
Pipe Line Cases, 266*n*.
Pipe line transportation, carrying capacity of, 262
  changes in factors affecting costs of, 262

Pipe line transportation, classes of companies controlling, 257
construction costs for, 260–261
control of, 257–260
control of crude petroleum prices by, 256–257
cost factors of, 260–263
decision declaring it a public utility, 265–266
Federal Trade Commission recommendations concerning, 268–269
fixed costs in, 262
of gasoline, 254
gathering line charges for, 264
growth and development of, 252–254
ineffectiveness of regulation of, 270
miles of, 254
and cost of, 262
miles of gasoline lines, 254
minimum tender requirements for, 264–265, 266
of natural gas, 70–74
networks, in the United States, 253–254
operating practices, 254–257
posting prices for, 256–257
pumping-station costs for, 261
pumping-station practices for, 261
rates, 264–265
regulation of, 265–270
reasons for, 265
shippers by, 263–264
significance of Interstate Commerce Commission minimum tender decision, 268
size of pipe lines for, 255–256
storage costs of, 261
tariff practices for, 266
tariffs for, ordered filed by the Interstate Commerce Commission, 265
total costs of, 261
transportation of gasoline by, 254
trunk line charges for, 264
use of, by outside shippers, 263–264
Pipe line transportation, variations in cost of construction for, 260–261
Pollution of water supplies, 133
Postal Telegraph and Cable Corporation, 299
Postal Telegraph Company, competition with Western Union, 378–381
coordination with domestic radio services, 345
rate structure of, 314–316
transatlantic cables of, 318
Pound, Dean Roscoe, 6
Prairie Oil and Gas Company v. United States, 266*n*.
Prairie Pipe Line Company, 267–268
Press telegraph services, 310
Press Wireless, Incorporated, 344, 362
Price, economic principles of, 26
nature of competitive, and monopoly, 26
Printing telegraph systems, 301–305
Private businesses, distinguished from public, 3–6
Private Wire Contracts, 312*n*.
Private wire services, in telegraph communication, 305
in telephone communication, 295–296
Producers Transportation Company v. Railroad Commission of California, 13*n*.
Promotional rates, in the electric light and power industry, 126
reasons for, 33
Propane gas, 58, 68
Public businesses, distinguished from private, 3–6
Public convenience and necessity, applied to radio broadcasting, 347–348
Public nature of rapid transit transportation, 209
Public Service Electric and Gas Company, of New Jersey, 108

Public utility, analogy as a test of, 9
bailment feature of, 7–8
conditions causing increase in businesses considered as, 5
duties and obligations of, 21
economic characteristics of, 20–22
judicial determination as ultimate test of, 19
kinds of businesses considered as, 8
legal concept of, 7–19
monopoly nature of, 26–27
origin of, 1–2
peculiar cost conditions in, 28–29
pipe line transportation, as a, 265–266
power of a state to declare a business to be, 13–19
privileges and rights of, 21–22
radio broadcasting not a, 346–348
recent increase in importance of, 4–5
scope of the term, 1
statutory definitions of, 22–24
tests of, 7
Public Utility Commission v. Monarch Refrigerating Company, 8*n.*
Public Works, 130
Public Works Administration, 115
Pure Oil Company, 256
Purification of water supplies, 138–140

R

Radio Act of 1927, 359
Radio communication, allocation of frequencies for, 357–358
alternators, 340
aviation services of, 362–363
broadcasting not a public utility, 346–348
broadcasting regulation necessary, 347–348
broadcasting services, 345–348
classes of service, 354
companies operating in United States, 339, 341–344
Radio communication, competitive advantages and disadvantages of, 352
domestic business, 344–345
economic characteristics of, 350
facsimile transmission, 341–342
government operated systems in the United States, 349–350
growth and development of, 338–345
International Radiotelegraph Convention, 355
International Telecommunication Convention, 354–358
licensing applicants, 361–363
load factor problems, 352–354
Madrid Conference, 356
marine services, 343, 344
need for international regulation, 357
North American Agreement, 358–359
principles underlying regulation of, 360–361
rates, 354
regulation of, 354–363
in the United States, 359–363
sea-letter telegrams, 342
special communication services, 348–349
vessels required to use, 338
volume of business, 344
United States policy toward international control, 356–357
Washington Conference, 355–356
Radio Corporation of America, contracts with General Electric, 340–341
formation of, 340
scope of activities, 341–342
status in transoceanic communication, 327
Radio frequencies, assignment of, 357–359
Radiomarine Corporation of America, 342
Radiotelephony, 278–280

R. C. A. Communications, Inc., 320, 342, 353, 354
Railroads, combinations among, 365–368
  consolidation provisions of the Transportation Act of 1920, 367
  coordination of services, 367–368
  and the Sherman Act, 366
  use of motorbuses by, 172–173
Railway Express Agency, trucks operated, 163
Rapid transit transportation, carrying capacity of, 222–224
  cities contemplating, 211–214
  cities having, 210–211
  coordination with surface transportation, 225–226
  cost of construction, 222–22?
  defined, 209
  effect, on real estate values. 216–218
    on taxes, 218–219
  elevated railways versus subways, 222
  fares, 226–227
  financing of, 214–222
  groups benefitted by, 214–219
  growth and development of, 210–214
  lines in the United States, 211
  need for, 209, 212–214
  plans for assessing costs of construction to groups benefitting from, 219–221
  public nature of, 209–210
  relations to the community, 215
  subway rolling stock equipment for, 224
  subways versus elevated railways, 222
Ratcliffe v. Wichita Union Stockyard Company, 8*n*.
Rate forms, advantages of demand type, 48–49
  block rates, 44–45, 153
  demand rates, 45
  Doherty, 124
Rate forms, flat, 42, 149
  flat demand, 47
  Hopkinson, 124
  with minimum charge, 44, 150–152
  obstacles to scientific, 42
  promotional and off-peak, 49–50, 126–127
  therm, 47–48
  three-part, 46
  with service charge, 43, 150–152
  step, 43–44, 153
  straight line meter, 43, 150
  unscientific nature of water supply, 149
  Wright-demand, 46–47, 124
Rate schedules, assessing costs to users, 27, 28–35, 38–42
  in cable communication, 333–337
  classification of customers for, 32
    for electric light and power, 125
    for manufactured gas, 41
  factors affecting, 35
  influence of cost of production on, 28–29
    of demand on, 27
    of diversity factor on, 30–31
    of load factor on, 30, 125
    of socio-economic conditions on, 33
    of supply on, 27
  in telegraph communication, 313–316
  in telephone communication, 285–295
  theoretically correct, 34
  theory and purpose of, 26–35
  use of demand type, 48–49
  water supply utility, 150–154
Rates, block, 44–45
  demand, 45
  distance, interurban electric railway transportation, 237
    street railway transportation, 205
  essentials of reasonable, 34–35
  gathering line, petroleum pipe line transportation, 264

Rates, for fire protection services of water supply utilities, 145–146
freight, interurban electric railway transportation, 247–248
manufactured gas, 35–42
natural gas, 78–81
off-peak, 30
passenger, interurban electric railway transportation, 237
pipe line transportation, 264–265
promotional, 33
radio communication, 354
service charges, telephone communication, 288
step, 43, 44
straight-line meter, 43
telegraph communication, 313–316
telephone communication, 286–290, 293
therm, 47–48
three-part, 46
street railway transportation, 200–208
variations in natural gas, 78
water supply, 147–148
zone, 205, 237, 294, 333
Real estate values, effect of rapid transit transportation on, 216–218
Refineries, location of petroleum, 251–252
shipments of crude petroleum to, 252
Reformed-oil-refinery gas, 57
Regional power areas, possible in United States, 109
Regulation, of cable communication, 335–336
of motor trucks, 164–166
need for international radio communication, 357
of pipe line transportation, 265–267
of radio communication, 354–363
standards for rate, 34–35
Retort coal gas, 57
Rich v. Kneeland, 2
Robert Dollar Steamship Company, 343, 362
Roosevelt, President Franklin D., attitude toward Muscle Shoals, 113
Rural electrification, efforts to develop, 98
farms served, 97
financing development of, 98
obstacles to, 98
Pennsylvania Joint Rural Electrification Committee, 100
Virginia Joint Committee on Rural Electrification, 100
Rural Electrification Administration, creation, 99
criticisms of, 100
purposes and program of, 99–100

S

School children, reduced street railway transportation fares for, 207
Scrymser, James A., 320
Seep Purchasing Agency, posting petroleum prices, 256–257
Selden, Henry R., 298
Selden, Samuel L., 298
Serial telegraph messages, 312
Settling and sedimentation of water supplies, 139
Shell Union Oil Corporation, ownership of pipe lines, 260
Sherman Act, and railroad combinations, 366
Ship-to-shore telephone service, 279–280
Sibley, Hiram, 298
Simplex operation of telegraphs, 301
Skelly Oil Company, 254
Socony-Vacuum Corporation, ownership of pipe lines, 260
South America, cable connections with the United States, 320–323
South Shore and South Bend interurban railways, 374

Southwestern Development Company, 374
Space heaters, 62
Special cable services, 332
Special rates for telegraph communication, 315
Square rates for telegraph communication, 314
Stafford v. Wallace, 8*n*.
Staggered closing hours, 196
Standard Gas and Electric Company, 369
Standard Oil Company, control of pipe lines, 256–257
  monopoly of pipe lines, 265
  posting petroleum prices, 256–257
  Seep Purchasing Agency of, 256
Standard Oil Company of Indiana, ownership of pipe lines, 260
Standard Oil Company of New Jersey, ownership of pipe lines, 258–260
  trucks operated, 163
Sta-Shine Products Company v. Station WGBB, 346*n*.
State rates for telegraph communication, 314
State v. S. P. and S. R. R., 9*n*.
Station-to-station telephone service, 292
Steam railways, use of motorbuses, 172–173
Steam turbines, use in electricity generation, 86
Step rates, 43–44
Straight-line meter rates, 43
Street railway transportation, adequate service problem, 195
  age of equipment used for, 182–183
  attempts to increase speed of operation, 196–197
  cable cars used for, 178–179
  classification of customers, 200
  coordination in, 191–194
  coordination with rapid transit transportation, 225–226
  cost factors, 198
Street railway transportation, demand factors, 199
  earnings from, 183–185
  evening passes, 203–204
  distance rates for, 205
  express-car service, 196
  fare levels, 197–198
  fare structure of, 200–208
  fields for use of motorbuses, electric street cars and trolley buses, 189–190
  future trend of, 190–191
  history of, 178–183
  horse cars used for, 178
  ideal fares for, 207–208
  miscellaneous fares of, 206–207
  monthly passes for, 202–203
  motorbuses used in, 186–188
  near-side stopping, 197
  number of companies in, 183
  off-peak passes for, 203
  off-peak riding stimulated, 196
  opposite-direction fares, 206
  passengers carried per day, 194
  peak-load problems, 195–197
  periods in development of, 179–182
  permit cards for, 204
  present difficulties of, 182
  present status of, 183–184
  receiverships of, 185
  the service problem of, 194–197
  skip-stop service, 196
  staggered closing hours, 196
  taxicabs controlled by, 192–194
  theories of ideal fare structures for, 199–200
  transfers, 206
  trolley buses used in, 188–191
  types of propulsion for, 178–179
  weekly passes for, 201–202
  weekly punch-cards for, 204–205
  week-end passes for, 202
  wholesale and regular fares of, 200–201
  zone rates for, 205
Street widening, cost of, 224
Sources of water supply, 132–133

Subways, cost of, 222–224
rolling-stock equipment, 224
versus elevated railways, 222
(*See also* Rapid transit transportation)
Sutherland, Mr. Justice, 13, 14

T

Taft, Mr. Justice, 12
Tariffs, pipe line, filed with the Interstate Commerce Commission, 265–266
Taste and odor removal from water supplies, 139–140
Taxes, effect of rapid transit transportation on, 218–219
Taxicabs, 173–174, 192–194
Telegraph communication, advantages of a single system, 380
American companies in the transatlantic field, 319–320
cable connections to and from the United States, 324
carrier circuits for, 301
classes of service, 310–313
combinations in, 377–381
competition between Postal and Western Union, 378–381
control of, 299
cost factors, 307
cost of manual versus machine operation, 304
day letters, 310
distance as a factor in rates for, 308
division of transatlantic business, 320
duplex operation of, 301
economic characteristics of, 307–308
elements affecting rates, 308–309
growth and development of, 298–301
Interstate Commerce Commission, decision of private-wire services of, 311–312
languages permitted in, 309
Telegraph communication, length of messages as a factor in rates, 308–309
liability for errors in, 309–310
load-factor problems, 307–308
manual operation for, 304
multiplex operation for, 301
night letters, 310
night messages, 310
number of companies in, 299
page transmission, 303
present status, 299–301
press services, 310–311
printing telegraph systems for, 301–305
private-wire services, 305
rate-making for, 308–313
rate structures for, 313–316
revenues from, 300–301
serial messages, 312
simplex operation of, 301
special rates for, 315–316
square rates for, 314
state rates for, 314
supplemental services in, 306
tape transmission, 303
technical development, 301–305
telegrams, 310
timed-wire service, 306
United States Government messages, 311
users of private-wire services, 305
volume of, 324–326
volume discount rates for, 311–312
word count for rate making for, 309
zone rates for, 313–314
Telephone communication, American Telephone and Telegraph Company, control of, 272–275, 276
circuits in United States, 277
cost characteristics, 281–285
distribution of telephones throughout the world, 280–281
distribution of traffic, 282–285
division of joint toll rates in, 294

Telephone communication, economic characteristics of, 281–285
  the exchange- or base-rate area, 290–292
  exchange rates, 285–292
  exchange service, 275
  growth and development of, 272–276
  independent systems in, 274–275
  integration in, 375–376
  long-distance services in, 276–278
  off-peak rates for, 285
  overseas services in, 279
  P.B.X. services, 289
  peak-load problems, 285
  phantom circuits for, 277
  private-wire services in, 295–296
  radiotelephony, 278–280
  rate structures for, 286–290
  reasons for combinations in, 376–377
  ship-to-shore services in, 279–280
  size of plant facilities for, 272
  technical improvements in, 276–277
  telephotograph services in, 296
  toll rates for, 292–293
  volume of, 272
  zone rates for, 290–292
Telephotograph services, telephone communication, 296
Teletypewriter services, telegraph communication, 306
Tennessee Electric Power Company v. Tennessee Valley Authority, 119*n*.
Tennessee Public Service Company, 118
Tennessee Valley Authority, as an application of a national power policy, 120
  area served, 116
  attempts to increase use of power, 121
    to lower rates, 121
  constitutionality of, 119
  contracts for supplying power, 116
Tennessee Valley Authority, creation of, 115
  the Electric Home and Farm Authority to assist in selling appliances, 122
  opposition to, 118
  principles underlying power policy of, 119
  regulations concerning power contracts, 117
  rural electrification activities of, 99
  significance of, 122
  scope of activities of, 116
  state and local cooperation with, 116, 118
  suits testing constitutionality of, 119
Texas Corporation, ownership of pipe lines, 260
Therm, defined, 48
  rates, 47–48
Thompson-Houston Company, 110
Thornton, Sir Henry Worth, 389
Three-part rates, 46
Tidewater Pipe Company, 253
Timed-wire service, telegraph communication, 306
  telephone communication, 311-312
Toll rates, telephone communication, 292–293
Tompkins, William, 70
Transandine Telegraph Company, 321
Transatlantic cables, 317–320
Transfer privileges, street railway transportation, 206
Transmission of electric current, circuits for, 105
  lines for, 104–105
  losses in, 104
  networks of, 105
Transpacific cables, 323–326
Transpacific Communication Company, 279
Transportation Act of 1920, railroad consolidation provisions of, 367

Trolley buses, use in urban transportation, 188–191
Tropical Radio Telegraph Company, 339, 343, 362
Trucks, large fleets of, 163
Tupelo, Mississippi, contract for T. V. A. power, 116
Turnover of capital, in public utilities, 28
Tyson and Brother v. Banton, 13, 18

U

United Corporation, holding-company group, 368, 371
United Fruit Company, 339, 343
United Parcel Service, trucks operated by, 163
United States, government telegraph messages, 311
  policy toward international radio control, 356–357
United States and Haiti Telegraph and Cable Company, 322
United States Department of Agriculture, Bureau of Public Roads, 164
United States Department of Commerce, radiotelegraph system of, 350
United States Liberia Radio Corporation, 344, 362
United States Navy Department, radiotelegraph system, 350
United States Railroad Administration, 366
United States Treasury Department, radiotelegraph system of, 350
United States Trucking Company, trucks operated, 163
United States War Department, cable and radio system of, 350
Unlimited weekly passes, street railway transportation, 201
Urban transportation (*see* Motor transportation; Rapid transit transportation; Street railway transportation)
Urgent message cablegrams, 331
Utility anti-merchandising laws, 94

V

Van Syckel, Samuel, 252
Vickers, Leslie, 215
Virginia Joint Committee on Rural Electrification, 100
Vocations, common, 1–3
Volume discount rates, telegraph communication, 311

W

Waite, Mr. Justice, 13
Washington International Radio Conference, 355–356
Water, consumption of, 133
  essentials of a satisfactory supply of, 132
  qualities necessary in, 131
  softening, 140
  uses of, 131
Water gas, 55
Water supply utilities, charges for fire-protection services by, 145–146
  combinations in, 374–375
  contamination and pollution in, 133
  cost conditions in, 147–148
  demand conditions in, 148–149
  distant sources of supply for, 132–133
  distribution systems for, 137–138
  economic characteristics of, 131–135
  effect of metering on consumption, 133
    on wastes, 141–142
  extent of municipal ownership of, 134
  financial control in municipal systems, 135
  financing extensions for, 136–137
  fire protection services of, 143–147
  investment required for fire protection services, 143–144

Water supply utilities, legal responsibility for pure water, 143
meter reading, 142–143
metering practices, 141–142
meters, 140
need for nonpolitical control of, 135
present status of, 130–131
problems of, 135–143
pumping stations, 137
purification practices of, 138–140
softening practices of, 140
rate schedules, 150–154
rates for, 147–155
reasons for municipal ownership of, 134
sources of water supply for, 132
taste and odor removal practices, 139–140
unscientific nature of rates for, 149
value of fire protection services of, 146
wastes of water in, 133, 141
Waterworks, in ancient times, 129
development of modern, 129–130
early American, 129
present status of, 130
Week-end passes, street railway transportation, 202
Weekly punch cards, street railway transportation, 204
Welsbach mantle, 52
West India and Panama Telegraph Company, 320
West Indies, cable communications with U. S., 320–323
Western Radio Telegraph Company, 345
Western Telegraph Company, 320, 321, 322, 323
Western Union Telegraph Company, cable business and revenues of, 324–326
competition with Postal system, 378–381
connections to South America, 322
organization and growth of, 289–299
permalloy cables, 326, 328
rate structure of, 314–316
transatlantic cables of, 317–318
Wholesale and regular fares, street railway transportation, 200–201
Winsor, Frederic, 51
Word count, in cable communication, 335–337
in radio communication, 354
in telegraph communication, 309
Wright demand rate, 46–47, 124

Z

Zone rates, in cable communication, 333
in interurban electric railway transportation, 237
in street railway transportation, 205
in telephone communication, 294